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(54) **INSTRUMENT SEAL FOR SURGICAL ACCESS ASSEMBLY**

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CPC ***A61B 17/3462*** (2013.01); ***A61B 17/3423*** (2013.01); ***A61B 17/3498*** (2013.01); *A61B 2017/3425* (2013.01)

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(56) **References Cited**

U.S. PATENT DOCUMENTS

3,402,710	A	9/1968	Paleschuck
3,495,586	A	2/1970	Regenbogen
4,016,884	A	4/1977	Kwan-Gett
4,112,932	A	9/1978	Chiulli

(Continued)

FOREIGN PATENT DOCUMENTS

EP	3219268	A1	9/2017
WO	2012131746	A1	10/2012
WO	2016110720	A1	7/2016

OTHER PUBLICATIONS

European Office Action dated Aug. 29, 2023, issued in corresponding EP Application No. 21163414, 5 pages.

(Continued)

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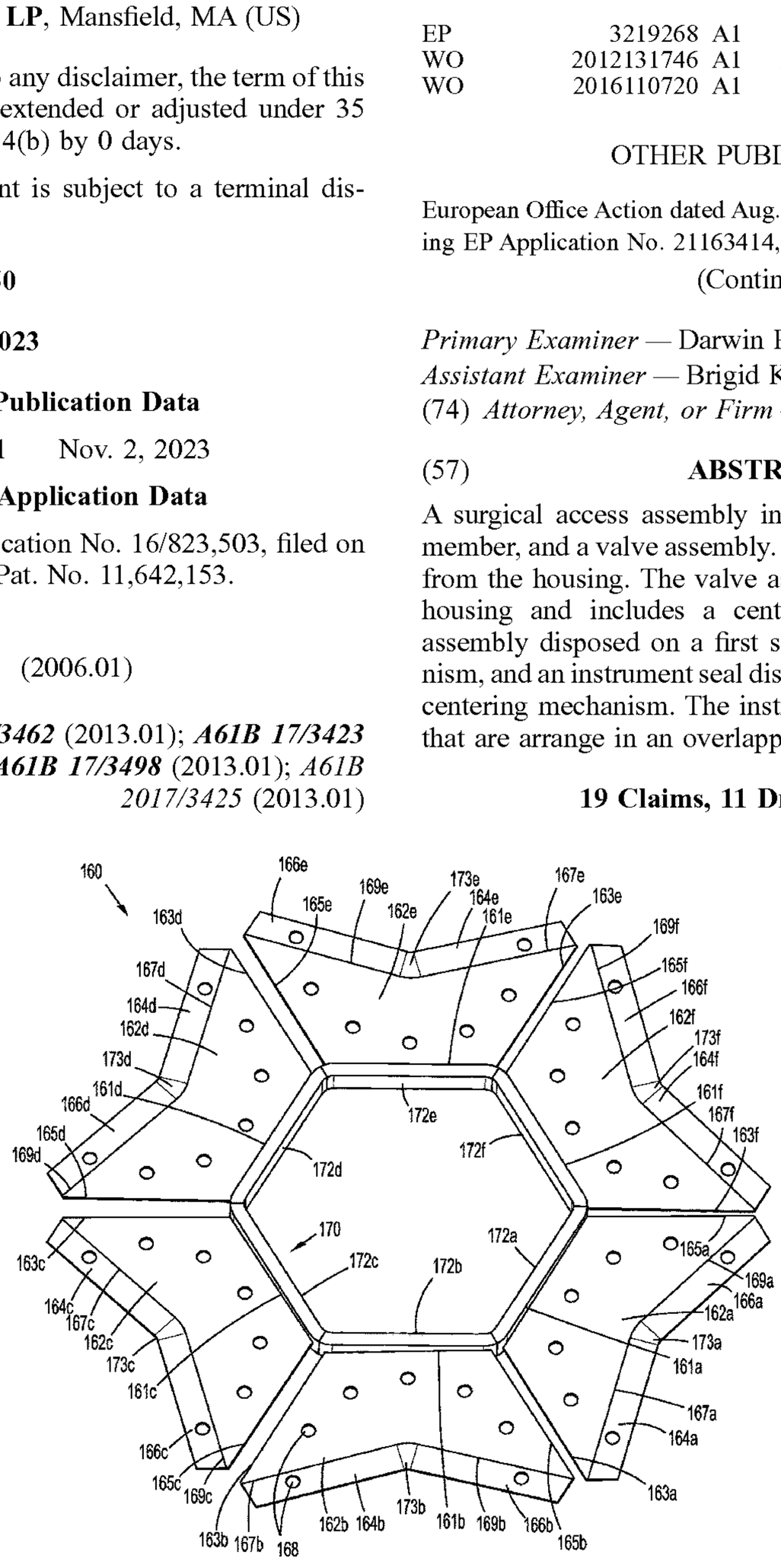
(57) **ABSTRACT**

A surgical access assembly includes a housing, a tubular member, and a valve assembly. The tubular member extends from the housing. The valve assembly is positioned in the housing and includes a centering mechanism, a guard assembly disposed on a first side of the centering mechanism, and an instrument seal disposed on a second side of the centering mechanism. The instrument seal including petals that are arrange in an overlapping arrangement.

19 Claims, 11 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

4,183,357	A	1/1980	Bentley et al.
4,356,826	A	11/1982	Kubota
4,402,683	A	9/1983	Kopman
4,619,643	A	10/1986	Bai
4,653,476	A	3/1987	Bonnet
4,737,148	A	4/1988	Blake
4,863,430	A	9/1989	Klyce et al.
4,863,438	A	9/1989	Gauderer et al.
4,984,564	A	1/1991	Yuen
5,002,557	A	3/1991	Hasson
5,073,169	A	12/1991	Raiken
5,082,005	A	1/1992	Kaldany
5,122,122	A	6/1992	Allgood
5,159,921	A	11/1992	Hoover
5,176,697	A	1/1993	Hasson
5,183,471	A	2/1993	Wilk
5,192,301	A	3/1993	Kamiya et al.
5,209,741	A	5/1993	Spaeth
5,209,754	A	5/1993	Ahluwalia
5,217,466	A	6/1993	Hasson
5,242,409	A	9/1993	Buelna
5,242,415	A	9/1993	Kantrowitz et al.
5,257,973	A	11/1993	Villasuso
5,257,975	A	11/1993	Foshee
5,269,772	A	12/1993	Wilk
5,271,380	A	12/1993	Riek et al.
5,290,245	A	3/1994	Dennis
5,290,249	A	3/1994	Foster et al.
5,308,336	A	5/1994	Hart et al.
5,312,391	A	5/1994	Wilk
5,312,417	A	5/1994	Wilk
5,314,417	A	5/1994	Stephens et al.
5,318,516	A	6/1994	Cosmescu
5,330,486	A	7/1994	Wilk
5,334,143	A	8/1994	Carroll
5,334,150	A	8/1994	Kaali
5,336,169	A	8/1994	Divilio et al.
5,336,203	A	8/1994	Goldhardt et al.
5,337,937	A	8/1994	Remiszewski et al.
5,345,927	A	9/1994	Bonutti
5,346,459	A	9/1994	Allen
5,360,417	A	11/1994	Gravener et al.
5,366,478	A	11/1994	Brinkerhoff et al.
5,375,588	A	12/1994	Yoon
5,378,588	A	1/1995	Tsuchiya
5,380,291	A	1/1995	Kaali
5,385,552	A	1/1995	Haber et al.
5,385,553	A	1/1995	Hart et al.
5,391,156	A	2/1995	Hildwein et al.
5,394,863	A	3/1995	Sanford et al.
5,395,367	A	3/1995	Wilk
5,407,433	A	4/1995	Loomas
5,431,151	A	7/1995	Riek et al.
5,437,683	A	8/1995	Neumann et al.
5,445,615	A	8/1995	Yoon
5,451,222	A	9/1995	De Maagd et al.
5,460,170	A	10/1995	Hammerslag
5,464,409	A	11/1995	Mohajer
5,480,410	A	1/1996	Cuschieri et al.
5,490,843	A	2/1996	Hildwein et al.
5,507,758	A	4/1996	Thomason et al.
5,511,564	A	4/1996	Wilk
5,514,133	A	5/1996	Golub et al.
5,514,153	A	5/1996	Bonutti
5,520,610	A	5/1996	Giglio et al.
5,520,698	A	5/1996	Koh
5,522,791	A	6/1996	Leyva
5,524,501	A	6/1996	Patterson et al.
5,524,644	A	6/1996	Crook
5,538,509	A	7/1996	Dunlap et al.
5,540,648	A	7/1996	Yoon
5,545,150	A	8/1996	Danks et al.
5,545,179	A	8/1996	Williamson, IV
5,549,565	A	8/1996	Ryan et al.
5,551,947	A	9/1996	Kaali
5,556,385	A	9/1996	Andersen
5,569,159	A	10/1996	Anderson et al.
5,569,205	A	10/1996	Hart et al.
5,569,291	A	10/1996	Privitera et al.
5,569,292	A	10/1996	Scwemberger et al.
5,577,993	A	11/1996	Zhu et al.
5,591,192	A	1/1997	Privitera et al.
5,601,581	A	2/1997	Fogarty et al.
5,609,562	A	3/1997	Kaali
5,624,399	A	4/1997	Ackerman
5,634,911	A	6/1997	Hermann et al.
5,634,937	A	6/1997	Mollenauer et al.
5,643,285	A	7/1997	Rowden et al.
5,649,550	A	7/1997	Crook
5,651,771	A	7/1997	Tangherlini et al.
5,653,705	A	8/1997	de la Torre et al.
5,656,013	A	8/1997	Yoon
5,672,168	A	9/1997	de la Torre et al.
5,683,378	A	11/1997	Christy
5,685,820	A	11/1997	Riek et al.
5,685,857	A	11/1997	Negus et al.
5,685,862	A	11/1997	Mahurkar
5,697,946	A	12/1997	Hopper et al.
5,709,671	A	1/1998	Stephens et al.
5,709,675	A	1/1998	Williams
5,713,858	A	2/1998	Heruth et al.
5,713,869	A	2/1998	Morejon
5,720,730	A	2/1998	Blake, III
5,720,761	A	2/1998	Kaali
5,722,962	A	3/1998	Garcia
5,728,103	A	3/1998	Picha et al.
5,730,748	A	3/1998	Fogarty et al.
5,735,791	A	4/1998	Alexander, Jr. et al.
5,741,298	A	4/1998	MacLeod
5,752,970	A	5/1998	Yoon
5,776,112	A	7/1998	Stephens et al.
5,782,817	A	7/1998	Franzel et al.
5,792,113	A	8/1998	Kramer et al.
5,795,290	A	8/1998	Bridges
5,800,451	A	9/1998	Buess et al.
5,803,921	A	9/1998	Bonadio
5,810,712	A	9/1998	Dunn
5,813,409	A	9/1998	Leahy et al.
5,830,191	A	11/1998	Hildwein et al.
5,836,871	A	11/1998	Wallace et al.
5,836,913	A	11/1998	Orth et al.
5,840,077	A	11/1998	Rowden et al.
5,842,971	A	12/1998	Yoon
5,848,992	A	12/1998	Hart et al.
5,853,417	A	12/1998	Fogarty et al.
5,857,461	A	1/1999	Levitsky et al.
5,865,817	A	2/1999	Moenning et al.
5,871,471	A	2/1999	Ryan et al.
5,871,474	A	2/1999	Hermann et al.
5,876,413	A	3/1999	Fogarty et al.
5,893,875	A	4/1999	O'Connor et al.
5,894,843	A	4/1999	Benetti et al.
5,895,377	A	4/1999	Smith et al.
5,899,208	A	5/1999	Bonadio
5,899,913	A	5/1999	Fogarty et al.
5,904,703	A	5/1999	Gilson
5,906,577	A	5/1999	Beane et al.
5,914,415	A	6/1999	Tago
5,916,198	A	6/1999	Dillow
5,941,898	A	8/1999	Moenning et al.
5,951,588	A	9/1999	Moenning
5,957,913	A	9/1999	de la Torre et al.
5,964,781	A	10/1999	Mollenauer et al.
5,976,174	A	11/1999	Ruiz
5,997,515	A	12/1999	de la Torre et al.
6,007,481	A	12/1999	Riek et al.
6,017,355	A	1/2000	Hessel et al.
6,018,094	A	1/2000	Fox
6,024,736	A	2/2000	de la Torre et al.
6,030,402	A	2/2000	Thompson et al.
6,033,426	A	3/2000	Kaji
6,033,428	A	3/2000	Sardella
6,042,573	A	3/2000	Lucey
6,048,309	A	4/2000	Flom et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,059,816	A	5/2000	Moenning
6,068,639	A	5/2000	Fogarty et al.
6,077,288	A	6/2000	Shimomura et al.
6,086,603	A	7/2000	Termin et al.
6,093,176	A	7/2000	Dennis
6,099,505	A	8/2000	Ryan et al.
6,099,506	A	8/2000	Macoviak et al.
6,110,154	A	8/2000	Shimomura et al.
6,142,936	A	11/2000	Beane et al.
6,156,006	A	12/2000	Brosens et al.
6,162,196	A	12/2000	Hart et al.
6,171,282	B1	1/2001	Ragsdale
6,197,002	B1	3/2001	Peterson
6,213,957	B1	4/2001	Milliman et al.
6,217,555	B1	4/2001	Hart et al.
6,228,063	B1	5/2001	Aboul-Hosn
6,234,958	B1	5/2001	Snoke et al.
6,238,373	B1	5/2001	de la Torre et al.
6,241,768	B1	6/2001	Agarwal et al.
6,251,119	B1	6/2001	Addis
6,254,534	B1	7/2001	Butler et al.
6,264,604	B1	7/2001	Kieturakis et al.
6,276,661	B1	8/2001	Laird
6,293,952	B1	9/2001	Brosens et al.
6,315,770	B1	11/2001	de la Torre et al.
6,319,246	B1	11/2001	de la Torre et al.
6,328,720	B1	12/2001	McNally et al.
6,329,637	B1	12/2001	Hembree et al.
6,355,028	B2	3/2002	Castaneda et al.
6,371,968	B1	4/2002	Kogasaka et al.
6,382,211	B1	5/2002	Crook
6,423,036	B1	7/2002	Van Huizen
6,440,061	B1	8/2002	Wenner et al.
6,440,063	B1	8/2002	Beane et al.
6,443,957	B1	9/2002	Addis
6,447,489	B1	9/2002	Peterson
6,450,983	B1	9/2002	Rambo
6,454,783	B1	9/2002	Piskun
6,464,686	B1	10/2002	O'Hara et al.
6,468,292	B1	10/2002	Mollenauer et al.
6,478,806	B2	11/2002	McFarlane
6,485,410	B1	11/2002	Loy
6,485,467	B1	11/2002	Crook et al.
6,487,806	B2	12/2002	Murello et al.
6,488,620	B1	12/2002	Segermark et al.
6,488,692	B1	12/2002	Spence et al.
6,524,283	B1	2/2003	Hopper et al.
6,527,787	B1	3/2003	Fogarty et al.
6,544,210	B1	4/2003	Trudel et al.
6,551,270	B1	4/2003	Bimbo et al.
6,551,282	B1	4/2003	Exline et al.
6,558,371	B2	5/2003	Dorn
6,562,022	B2	5/2003	Hoste et al.
6,569,120	B1	5/2003	Green et al.
6,572,631	B1	6/2003	McCartney
6,578,577	B2	6/2003	Bonadio et al.
6,582,364	B2	6/2003	Butler et al.
6,589,167	B1	7/2003	Shimomura et al.
6,589,316	B1	7/2003	Schultz et al.
6,592,543	B1	7/2003	Wortrich et al.
6,613,038	B2	9/2003	Bonutti et al.
6,613,952	B2	9/2003	Rambo
6,623,426	B2	9/2003	Bonadio et al.
6,669,674	B1	12/2003	Macoviak et al.
6,676,639	B1	1/2004	Ternstrom
6,684,405	B2	2/2004	Ezdey
6,702,787	B2	3/2004	Racenet et al.
6,706,050	B1	3/2004	Giannadakis
6,716,201	B2	4/2004	Blanco
6,723,044	B2	4/2004	Pulford et al.
6,723,088	B2	4/2004	Gaskill, III et al.
6,725,080	B2	4/2004	Melkent et al.
6,736,797	B1	5/2004	Larsen et al.
6,740,064	B1	5/2004	Sorrentino et al.
6,800,084	B2	10/2004	Davison et al.
6,811,546	B1	11/2004	Callas et al.
6,814,078	B2	11/2004	Crook
6,830,578	B2	12/2004	O'Heeron et al.
6,835,201	B2	12/2004	O'Heeron et al.
6,837,893	B2	1/2005	Miller
6,840,946	B2	1/2005	Fogarty et al.
6,840,951	B2	1/2005	de la Torre et al.
6,846,287	B2	1/2005	Bonadio et al.
6,855,128	B2	2/2005	Swenson
6,863,674	B2	3/2005	Kasahara et al.
6,878,110	B2	4/2005	Yang et al.
6,884,253	B1	4/2005	McFarlane
6,890,295	B2	5/2005	Michels et al.
6,913,609	B2	7/2005	Yencho et al.
6,916,310	B2	7/2005	Sommerich
6,916,331	B2	7/2005	Mollenauer et al.
6,929,637	B2	8/2005	Gonzalez et al.
6,939,296	B2	9/2005	Ewers et al.
6,942,633	B2	9/2005	Odland
6,942,671	B1	9/2005	Smith
6,945,932	B1	9/2005	Caldwell et al.
6,958,037	B2	10/2005	Ewers et al.
6,960,164	B2	11/2005	O'Heeron
6,972,026	B1	12/2005	Caldwell et al.
6,986,752	B2	1/2006	McGuckin, Jr. et al.
6,991,602	B2	1/2006	Nakazawa et al.
6,997,909	B2	2/2006	Goldberg
7,001,397	B2	2/2006	Davison et al.
7,008,377	B2	3/2006	Beane et al.
7,011,645	B2	3/2006	McGuckin, Jr. et al.
7,014,628	B2	3/2006	Bousquet
7,033,319	B2	4/2006	Pulford et al.
7,052,454	B2	5/2006	Taylor
7,056,321	B2	6/2006	Pagliuca et al.
7,077,852	B2	7/2006	Fogarty et al.
7,081,089	B2	7/2006	Bonadio et al.
7,083,626	B2	8/2006	Hart et al.
7,100,614	B2	9/2006	Stevens et al.
7,101,353	B2	9/2006	Lui et al.
7,104,981	B2	9/2006	Elkins et al.
7,153,261	B2	12/2006	Wenchell
7,160,309	B2	1/2007	Voss
7,163,510	B2	1/2007	Kahle et al.
7,192,436	B2	3/2007	Sing et al.
7,195,590	B2	3/2007	Butler et al.
7,201,725	B1	4/2007	Cragg et al.
7,214,185	B1	5/2007	Rosney et al.
7,217,277	B2	5/2007	Parihar et al.
7,223,257	B2	5/2007	Shubayev et al.
7,223,278	B2	5/2007	Davison et al.
7,235,064	B2	6/2007	Hopper et al.
7,235,084	B2	6/2007	Skakoon et al.
7,238,154	B2	7/2007	Ewers et al.
7,258,712	B2	8/2007	Schultz et al.
7,276,075	B1	10/2007	Callas et al.
7,294,103	B2	11/2007	Bertolero et al.
7,300,399	B2	11/2007	Bonadio et al.
7,300,448	B2	11/2007	Criscuolo et al.
7,316,699	B2	1/2008	McFarlane
7,320,694	B2	1/2008	O'Heeron
7,331,940	B2	2/2008	Sommerich
7,344,547	B2	3/2008	Piskun
7,370,694	B2	5/2008	Shimizu et al.
7,377,898	B2	5/2008	Ewers et al.
7,390,322	B2	6/2008	McGuckin, Jr. et al.
7,393,322	B2	7/2008	Wenchell
7,412,977	B2	8/2008	Fields et al.
7,440,661	B2	10/2008	Kobayashi
7,445,597	B2	11/2008	Butler et al.
7,452,363	B2	11/2008	Ortiz
7,473,221	B2	1/2009	Ewers et al.
7,481,765	B2	1/2009	Ewers et al.
7,493,703	B2	2/2009	Kim et al.
7,494,481	B2	2/2009	Moberg et al.
7,513,361	B1	4/2009	Mills, Jr.
7,513,461	B2	4/2009	Reutenauer et al.
7,520,876	B2	4/2009	Ressemann et al.
7,537,564	B2	5/2009	Bonadio et al.
7,540,839	B2	6/2009	Butler et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,559,893	B2	7/2009	Bonadio et al.
7,608,082	B2	10/2009	Cuevas et al.
7,625,361	B2	12/2009	Suzuki et al.
7,645,232	B2	1/2010	Shluzas
7,650,887	B2	1/2010	Nguyen et al.
7,678,046	B2	3/2010	White et al.
7,686,823	B2	3/2010	Pingleton et al.
7,704,207	B2	4/2010	Albrecht et al.
7,708,713	B2	5/2010	Albrecht et al.
7,717,846	B2	5/2010	Zirps et al.
7,717,847	B2	5/2010	Smith
7,721,742	B2	5/2010	Kalloo et al.
7,727,146	B2	6/2010	Albrecht et al.
7,730,629	B2	6/2010	Kim
7,736,306	B2	6/2010	Brustad et al.
7,744,569	B2	6/2010	Smith
7,753,901	B2	7/2010	Piskun et al.
7,758,500	B2	7/2010	Boyd et al.
7,758,603	B2	7/2010	Taylor et al.
7,762,995	B2	7/2010	Eversull et al.
7,766,824	B2	8/2010	Jensen et al.
7,787,963	B2	8/2010	Geistert et al.
7,794,644	B2	9/2010	Taylor et al.
7,798,998	B2	9/2010	Thompson et al.
7,811,251	B2	10/2010	Wenchell et al.
7,815,567	B2	10/2010	Albrecht et al.
7,837,612	B2	11/2010	Gill et al.
7,846,123	B2	12/2010	Vassiliades et al.
7,850,600	B1	12/2010	Piskun
7,850,655	B2	12/2010	Pasqualucci
7,850,667	B2	12/2010	Gresham
7,867,164	B2	1/2011	Butler et al.
7,896,889	B2	3/2011	Mazzocchi et al.
7,905,829	B2	3/2011	Nishimura et al.
7,909,760	B2	3/2011	Albrecht et al.
7,913,697	B2	3/2011	Nguyen et al.
7,918,827	B2	4/2011	Smith
7,947,058	B2	5/2011	Kahle et al.
7,951,076	B2	5/2011	Hart et al.
7,955,257	B2	6/2011	Frasier et al.
7,955,313	B2	6/2011	Boismier
7,985,232	B2	7/2011	Potter et al.
7,998,068	B2	8/2011	Bonadio et al.
8,002,750	B2	8/2011	Smith
8,002,786	B2	8/2011	Beckman et al.
8,012,128	B2	9/2011	Franer et al.
8,021,296	B2	9/2011	Bonadio et al.
8,025,670	B2	9/2011	Sharp et al.
8,029,475	B2	10/2011	Franer et al.
8,038,652	B2	10/2011	Morrison et al.
8,052,653	B2	11/2011	Gratwohl et al.
8,066,673	B2	11/2011	Hart et al.
8,079,986	B2	12/2011	Taylor et al.
8,092,430	B2	1/2012	Richard et al.
8,092,431	B2	1/2012	Lunn et al.
8,105,234	B2	1/2012	Ewers et al.
8,109,873	B2	2/2012	Albrecht et al.
8,118,735	B2	2/2012	Voegele
8,128,590	B2	3/2012	Albrecht et al.
8,137,318	B2	3/2012	Schweitzer et al.
8,147,453	B2	4/2012	Albrecht et al.
8,152,828	B2	4/2012	Taylor et al.
8,157,786	B2	4/2012	Miller et al.
8,157,817	B2	4/2012	Bonadio et al.
8,187,177	B2	5/2012	Kahle et al.
8,187,178	B2	5/2012	Bonadio et al.
8,206,411	B2	6/2012	Thompson et al.
8,241,209	B2	8/2012	Shelton, IV et al.
8,262,568	B2	9/2012	Albrecht et al.
8,267,952	B2	9/2012	Kahle et al.
8,323,184	B2	12/2012	Spiegal et al.
8,335,783	B2	12/2012	Milby
8,343,047	B2	1/2013	Albrecht et al.
8,353,824	B2	1/2013	Shelton, IV et al.
8,398,666	B2	3/2013	McFarlane
8,403,889	B2	3/2013	Richard
8,480,683	B2	7/2013	Fowler et al.
8,574,153	B2	11/2013	Richard
8,585,632	B2	11/2013	Okoniewski
8,597,180	B2	12/2013	Copeland et al.
8,961,406	B2	2/2015	Ortiz et al.
10,022,149	B2	7/2018	Holsten et al.
10,568,660	B2	2/2020	Zhou
10,653,449	B2	5/2020	Main et al.
11,642,153	B2	5/2023	Pilletere et al.
2001/0037053	A1	11/2001	Bonadio et al.
2002/0055714	A1	5/2002	Rothschild
2002/0091410	A1	7/2002	Ben-David et al.
2002/0173748	A1	11/2002	McConnell et al.
2003/0014076	A1	1/2003	Mollenauer et al.
2003/0093104	A1	5/2003	Bonner et al.
2003/0109853	A1	6/2003	Harding et al.
2003/0187376	A1	10/2003	Rambo
2003/0187397	A1	10/2003	Vitali
2003/0233115	A1	12/2003	Eversull et al.
2003/0236549	A1	12/2003	Bonadio et al.
2004/0006356	A1	1/2004	Smith
2004/0054353	A1	3/2004	Taylor
2004/0059297	A1	3/2004	Racenet et al.
2004/0073090	A1	4/2004	Butler et al.
2004/0092795	A1	5/2004	Bonadio et al.
2004/0102804	A1	5/2004	Chin
2004/0111061	A1	6/2004	Curran
2004/0138529	A1	7/2004	Wiltshire et al.
2004/0186434	A1	9/2004	Harding et al.
2004/0204682	A1	10/2004	Smith
2004/0204734	A1	10/2004	Wagner et al.
2004/0215209	A1	10/2004	Almond et al.
2004/0267096	A1	12/2004	Caldwell et al.
2004/0267204	A1	12/2004	Brustowicz
2005/0010238	A1	1/2005	Potter et al.
2005/0020884	A1	1/2005	Hart et al.
2005/0033342	A1	2/2005	Hart et al.
2005/0070850	A1	3/2005	Albrecht
2005/0070851	A1	3/2005	Thompson et al.
2005/0070935	A1	3/2005	Ortiz
2005/0070946	A1	3/2005	Franer et al.
2005/0070947	A1	3/2005	Franer et al.
2005/0096695	A1	5/2005	Olich
2005/0119525	A1	6/2005	Takemoto
2005/0137459	A1	6/2005	Chin et al.
2005/0148823	A1	7/2005	Vaugh et al.
2005/0192483	A1	9/2005	Bonadio et al.
2005/0192594	A1	9/2005	Skakoon et al.
2005/0203346	A1	9/2005	Bonadio et al.
2005/0209608	A1	9/2005	O'Heeron
2005/0212221	A1	9/2005	Smith et al.
2005/0222582	A1	10/2005	Wenchell
2005/0245876	A1	11/2005	Khosravi et al.
2005/0251092	A1	11/2005	Howell et al.
2005/0251190	A1	11/2005	McFarlane
2005/0277946	A1	12/2005	Greenhalgh
2006/0020281	A1	1/2006	Smith
2006/0071432	A1	4/2006	Staudner
2006/0129165	A1	6/2006	Edoga et al.
2006/0149137	A1	7/2006	Pingleton et al.
2006/0149306	A1	7/2006	Hart et al.
2006/0161049	A1	7/2006	Beane et al.
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2006/0211992	A1	9/2006	Prosek
2006/0212063	A1	9/2006	Wilk
2006/0217665	A1	9/2006	Prosek
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2006/0241651	A1	10/2006	Wilk
2006/0247498	A1	11/2006	Bonadio et al.
2006/0247499	A1	11/2006	Butler et al.
2006/0247500	A1	11/2006	Voegele et al.
2006/0247516	A1	11/2006	Hess et al.
2006/0247586	A1	11/2006	Voegele et al.
2006/0247673	A1	11/2006	Voegele et al.
2006/0247678	A1	11/2006	Weisenburgh et al.
2006/0270911	A1	11/2006	Voegele et al.
2006/0276751	A1	12/2006	Haberland et al.
2007/0088277	A1	4/2007	McGinley et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2007/0093695	A1	4/2007	Bonadio et al.	
2007/0118175	A1	5/2007	Butler et al.	
2007/0151566	A1	7/2007	Kahle et al.	
2007/0185453	A1	8/2007	Michael et al.	
2007/0203398	A1	8/2007	Bonadio et al.	
2007/0208312	A1	9/2007	Norton et al.	
2007/0225650	A1	9/2007	Hart et al.	
2007/0239108	A1	10/2007	Albrecht et al.	
2007/0255218	A1*	11/2007	Franer	A61B 17/3462 604/167.02
2007/0270654	A1	11/2007	Pignato et al.	
2007/0270882	A1	11/2007	Hjelle et al.	
2008/0009826	A1	1/2008	Miller et al.	
2008/0021360	A1	1/2008	Fihe et al.	
2008/0027476	A1	1/2008	Piskun	
2008/0048011	A1	2/2008	Weller	
2008/0051739	A1	2/2008	McFarlane	
2008/0058723	A1	3/2008	Lipchitz et al.	
2008/0091143	A1	4/2008	Taylor et al.	
2008/0097162	A1	4/2008	Bonadio et al.	
2008/0097332	A1	4/2008	Greenhalgh et al.	
2008/0119868	A1	5/2008	Sharp et al.	
2008/0146884	A1	6/2008	Beckman et al.	
2008/0161758	A1	7/2008	Insignares	
2008/0161826	A1	7/2008	Guiraudon	
2008/0177265	A1	7/2008	Lechot	
2008/0188868	A1	8/2008	Weitzner et al.	
2008/0194973	A1	8/2008	Imam	
2008/0200767	A1	8/2008	Ewers et al.	
2008/0208222	A1	8/2008	Beckman et al.	
2008/0249475	A1	10/2008	Albrecht et al.	
2008/0255519	A1	10/2008	Piskun et al.	
2008/0319261	A1	12/2008	Lucini et al.	
2009/0012477	A1	1/2009	Norton et al.	
2009/0036738	A1	2/2009	Cuschieri et al.	
2009/0036745	A1	2/2009	Bonadio et al.	
2009/0093752	A1	4/2009	Richard et al.	
2009/0093835	A1	4/2009	Heinrich et al.	
2009/0093850	A1	4/2009	Richard	
2009/0105635	A1	4/2009	Bettuchi et al.	
2009/0131751	A1	5/2009	Spivey et al.	
2009/0137879	A1	5/2009	Ewers et al.	
2009/0182279	A1	7/2009	Wenchell et al.	
2009/0182288	A1	7/2009	Spenciner	
2009/0187079	A1	7/2009	Albrecht et al.	
2009/0204067	A1	8/2009	Abu-Halawa	
2009/0221968	A1	9/2009	Morrison et al.	
2009/0227843	A1	9/2009	Smith et al.	
2009/0234293	A1	9/2009	Albrecht et al.	
2009/0275880	A1	11/2009	Pasqualucci	
2009/0326330	A1	12/2009	Bonadio et al.	
2009/0326332	A1	12/2009	Carter	
2010/0016800	A1	1/2010	Rockrohr	
2010/0030155	A1	2/2010	Gyrn et al.	
2010/0049138	A1	2/2010	Smith et al.	
2010/0063450	A1	3/2010	Smith et al.	
2010/0063452	A1	3/2010	Edelman et al.	
2010/0081881	A1*	4/2010	Murray	A61B 17/3498 600/203
2010/0100043	A1	4/2010	Racenet	
2010/0113886	A1	5/2010	Piskun et al.	
2010/0222801	A1	9/2010	Pingleton et al.	
2010/0228090	A1	9/2010	Weisenburgh, II	
2010/0228094	A1	9/2010	Ortiz et al.	
2010/0228096	A1	9/2010	Weisenburgh, II et al.	
2010/0240960	A1	9/2010	Richard	
2010/0249516	A1	9/2010	Shelton, IV et al.	
2010/0249523	A1	9/2010	Spiegal et al.	
2010/0249524	A1	9/2010	Ransden et al.	
2010/0261975	A1	10/2010	Huey et al.	
2010/0262080	A1	10/2010	Shelton, IV et al.	
2010/0280326	A1	11/2010	Hess et al.	
2010/0286484	A1	11/2010	Stellon et al.	
2010/0286506	A1	11/2010	Ransden et al.	
2010/0286706	A1*	11/2010	Judson	A61B 17/3462 606/108
2010/0298646	A1	11/2010	Stellon et al.	
2010/0312063	A1	12/2010	Hess et al.	
2011/0009704	A1	1/2011	Marczyk et al.	
2011/0021877	A1	1/2011	Fortier et al.	
2011/0028891	A1	2/2011	Okoniewski	
2011/0034778	A1	2/2011	Kleyman	
2011/0054257	A1	3/2011	Stopek	
2011/0054258	A1	3/2011	O'Keefe et al.	
2011/0054260	A1	3/2011	Albrecht et al.	
2011/0082341	A1	4/2011	Kleyman et al.	
2011/0082343	A1	4/2011	Okoniewski	
2011/0082346	A1	4/2011	Stopek	
2011/0087159	A1	4/2011	Parihar et al.	
2011/0087168	A1	4/2011	Parihar et al.	
2011/0087169	A1	4/2011	Parihar et al.	
2011/0118553	A1	5/2011	Stopek	
2011/0118833	A1	5/2011	Reichenbach et al.	
2011/0124968	A1	5/2011	Kleyman	
2011/0124969	A1	5/2011	Stopek	
2011/0124970	A1	5/2011	Kleyman	
2011/0125186	A1	5/2011	Fowler et al.	
2011/0166423	A1	7/2011	Farascioni et al.	
2011/0190592	A1	8/2011	Kahle et al.	
2011/0201891	A1	8/2011	Smith et al.	
2011/0237901	A1	9/2011	Duke et al.	
2011/0251463	A1	10/2011	Kleyman	
2011/0251464	A1	10/2011	Kleyman	
2011/0251465	A1	10/2011	Kleyman	
2011/0251466	A1	10/2011	Kleyman et al.	
2011/0251559	A1	10/2011	Tal et al.	
2011/0251560	A1	10/2011	Albrecht et al.	
2011/0251633	A1	10/2011	Smith	
2011/0276002	A1	11/2011	Bierman	
2011/0313250	A1	12/2011	Kleyman	
2012/0010569	A1	1/2012	Parihar	
2012/0041371	A1	2/2012	Tal et al.	
2012/0059640	A1	3/2012	Roy et al.	
2012/0065590	A1	3/2012	Bierman et al.	
2012/0109064	A1	5/2012	Fischvogt et al.	
2012/0130177	A1	5/2012	Davis	
2012/0130181	A1	5/2012	Davis	
2012/0130182	A1	5/2012	Rodrigues, Jr. et al.	
2012/0130183	A1	5/2012	Barnes	
2012/0130184	A1	5/2012	Richard	
2012/0130185	A1	5/2012	Pribanic	
2012/0130186	A1	5/2012	Stopek et al.	
2012/0130187	A1	5/2012	Okoniewski	
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2012/0130190	A1	5/2012	Kasvikis	
2012/0130191	A1	5/2012	Pribanic	
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2012/0157783	A1	6/2012	Okoniewski et al.	
2012/0157784	A1	6/2012	Kleyman et al.	
2012/0157785	A1	6/2012	Kleyman	
2012/0157786	A1	6/2012	Pribanic	
2012/0190931	A1	7/2012	Stopek	
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2012/0245429	A1	9/2012	Smith	
2012/0245430	A1	9/2012	Kleyman et al.	
2012/0283520	A1	11/2012	Kleyman	
2012/0316596	A1	12/2012	Taylor et al.	
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2013/0310651	A1	11/2013	Alfieri	
2014/0018632	A1	1/2014	Kleyman	
2015/0025477	A1	1/2015	Evans	

(56) **References Cited**

U.S. PATENT DOCUMENTS

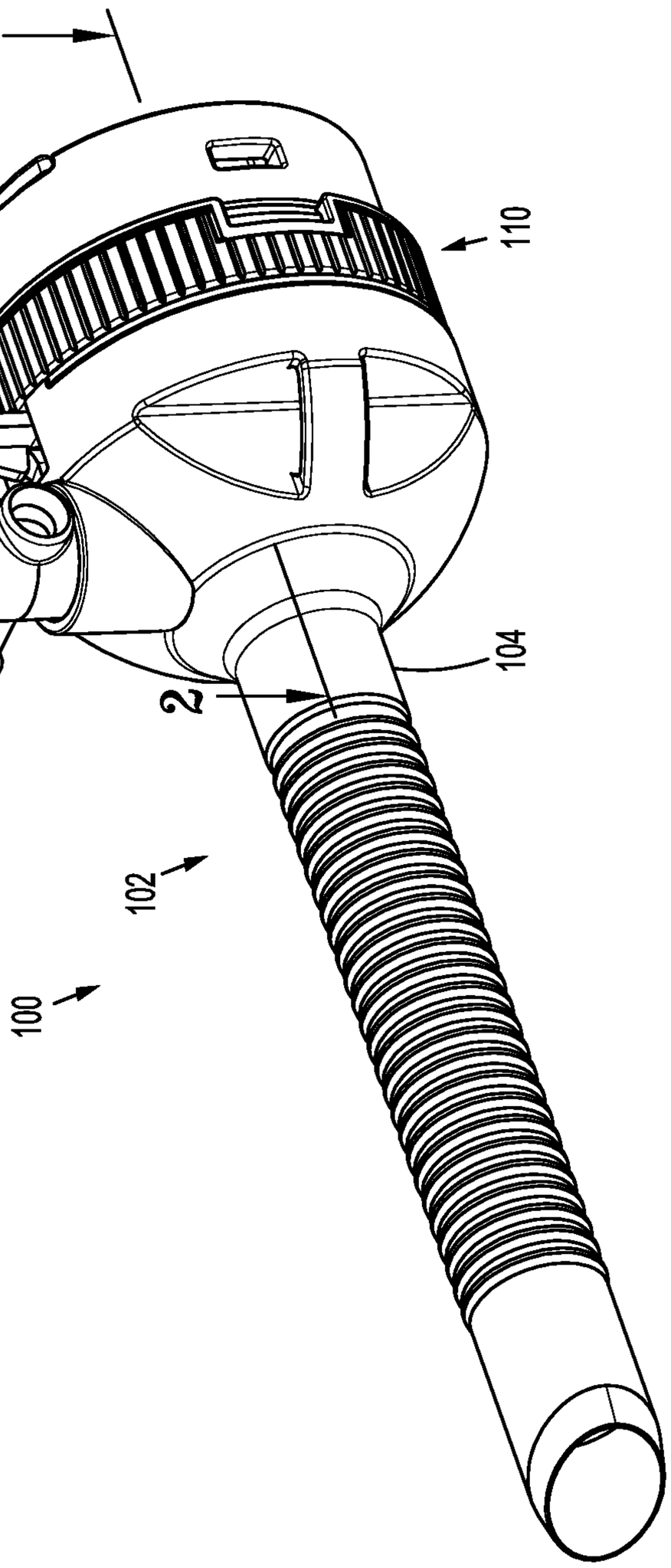
2015/0065808	A1	3/2015	Van Wyk et al.	
2015/0223833	A1	8/2015	Coffeen et al.	
2018/0021063	A1*	1/2018	Main	A61B 17/3474 604/167.01
2018/0085145	A1*	3/2018	Okoniewski	A61B 17/3462
2019/0059938	A1	2/2019	Holsten	
2019/0059944	A1	2/2019	Holsten	
2020/0246043	A1	8/2020	Holsten et al.	
2021/0213269	A1*	7/2021	Venskytis	A61B 34/30

OTHER PUBLICATIONS

Partial European Search Report dated Jul. 21, 2021 issued in corresponding EP Appln. No. 21163414.2.

Extended European Search Report dated Nov. 25, 2021 issued in corresponding EP Appln. No. 21163414.2.

* cited by examiner



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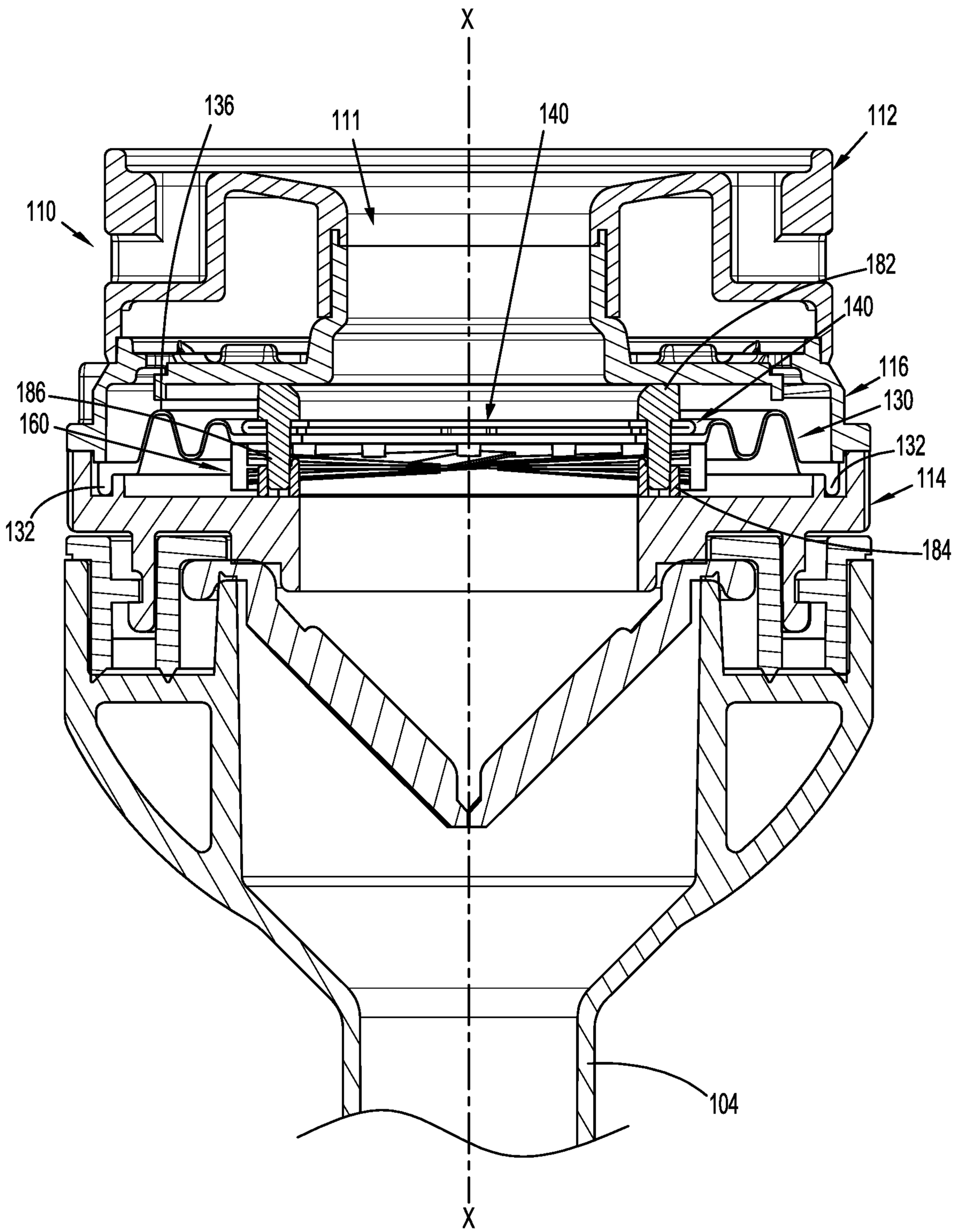
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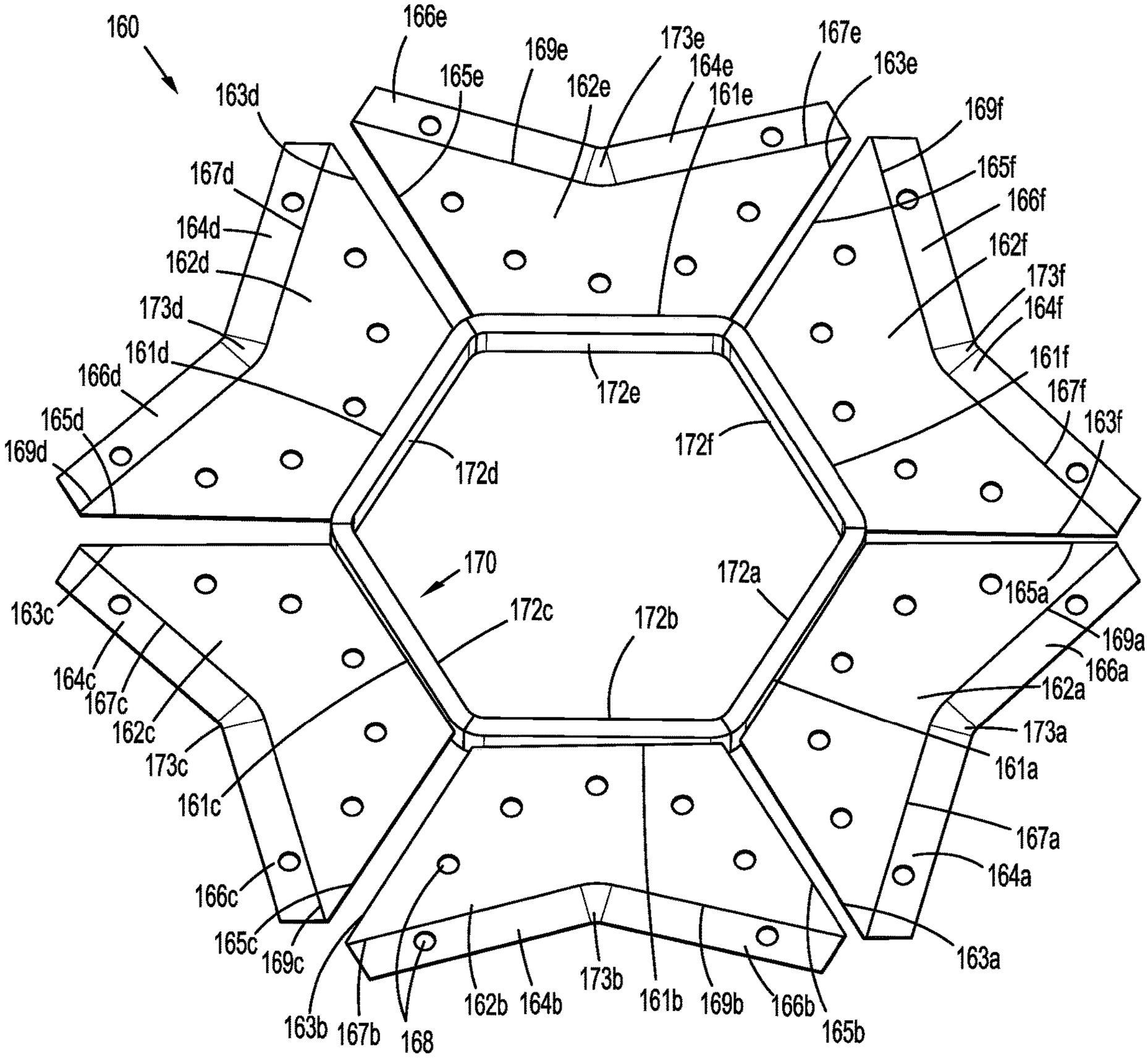
FIG. 2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167f
163f
172e
172f
172d
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172a
172c
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167c
162c
173c
161c
166c
165c
169c
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169a
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162a
173a
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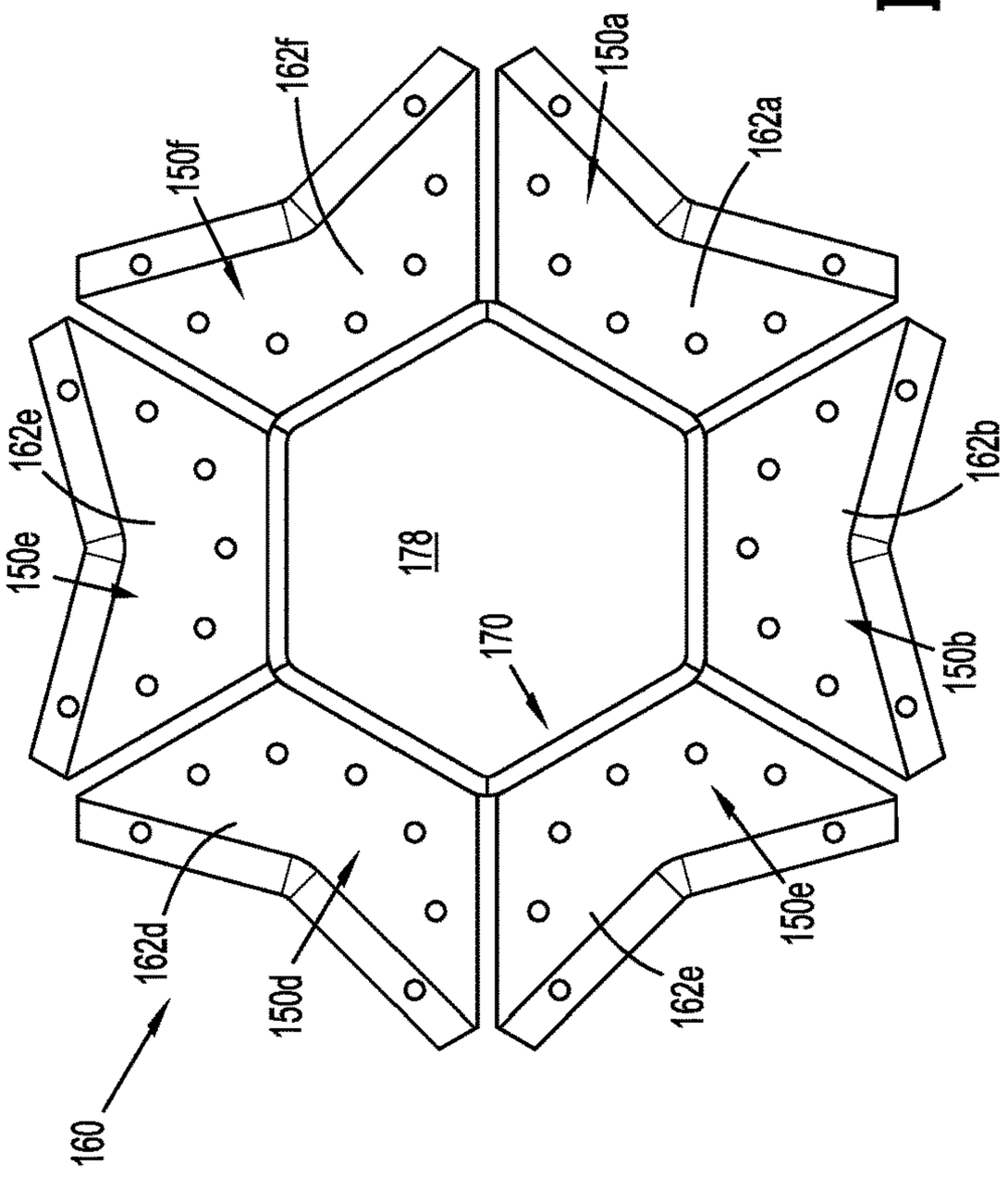
165b

FIG. 3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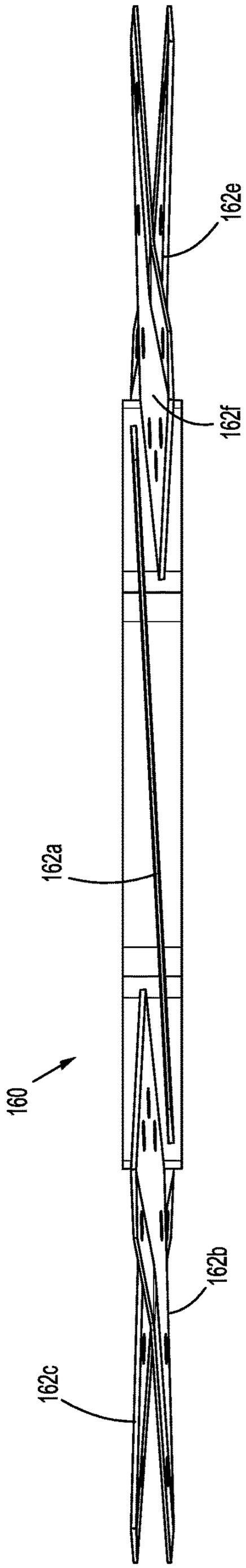
150a
162a
150b
162b
170
178

FIG. 4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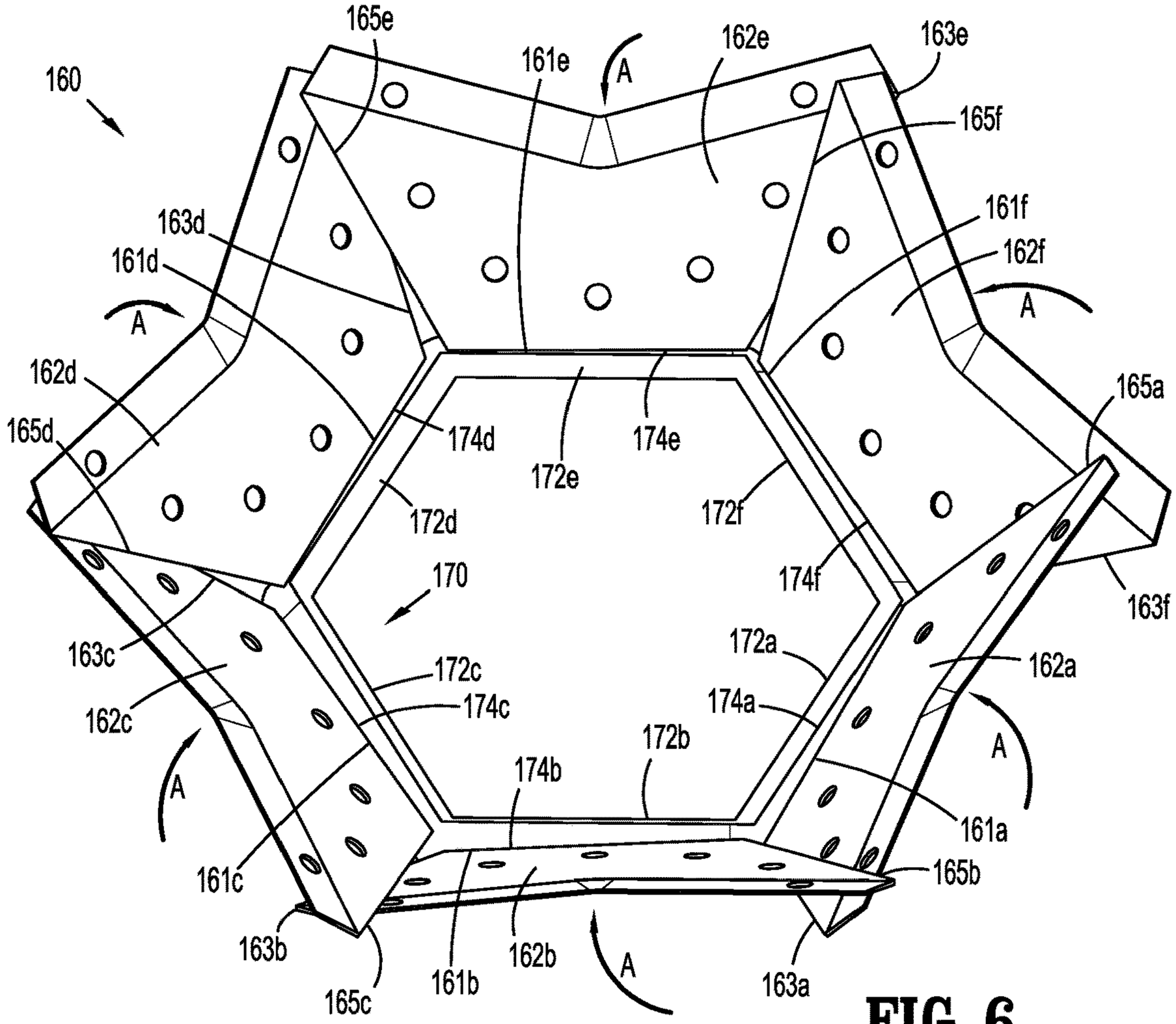
162b
162c
162e
162f

FIG. 5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162d
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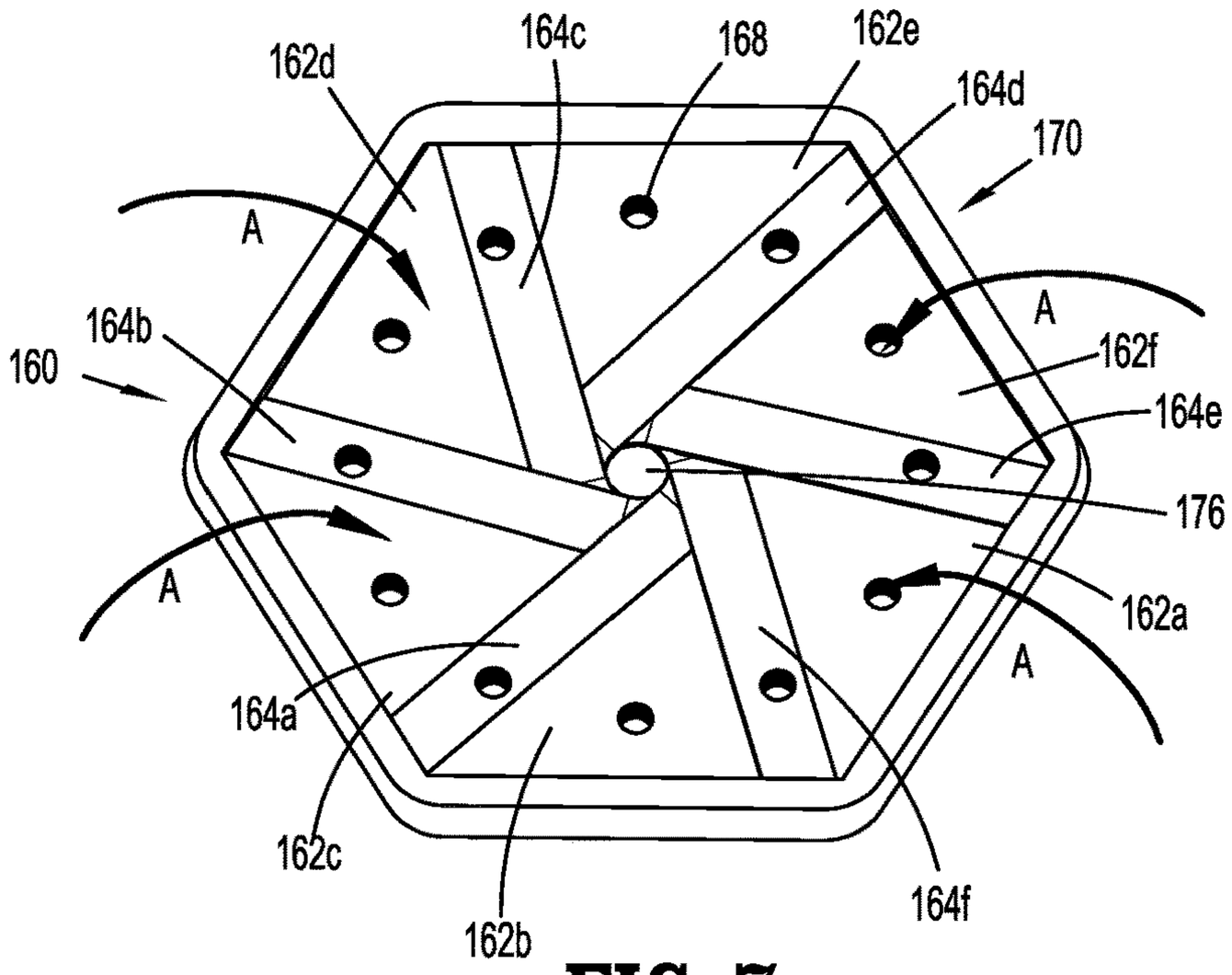
172e
174e
172f
174f
163f
172d
170
172a
162a
163c
172c
174c
174a
162c
172b
A
174b
161a
A
161c
165b
163b
162b
A
161b
165c
163a

FIG. 6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162e
162d
164d
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164b
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162f
164e
176
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162a
A
164a
162c
164f
162b

FIG. 7

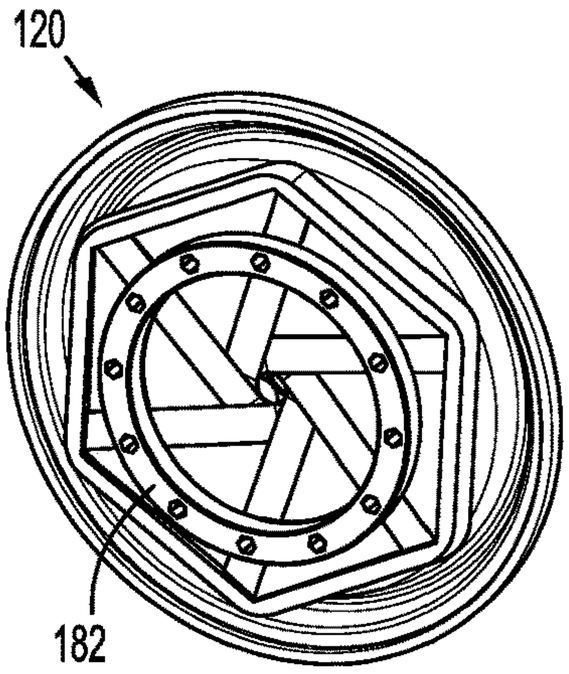
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FIG. 8

182
186
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142
144c
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146
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130
180
160
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168
184
188

FIG. 9

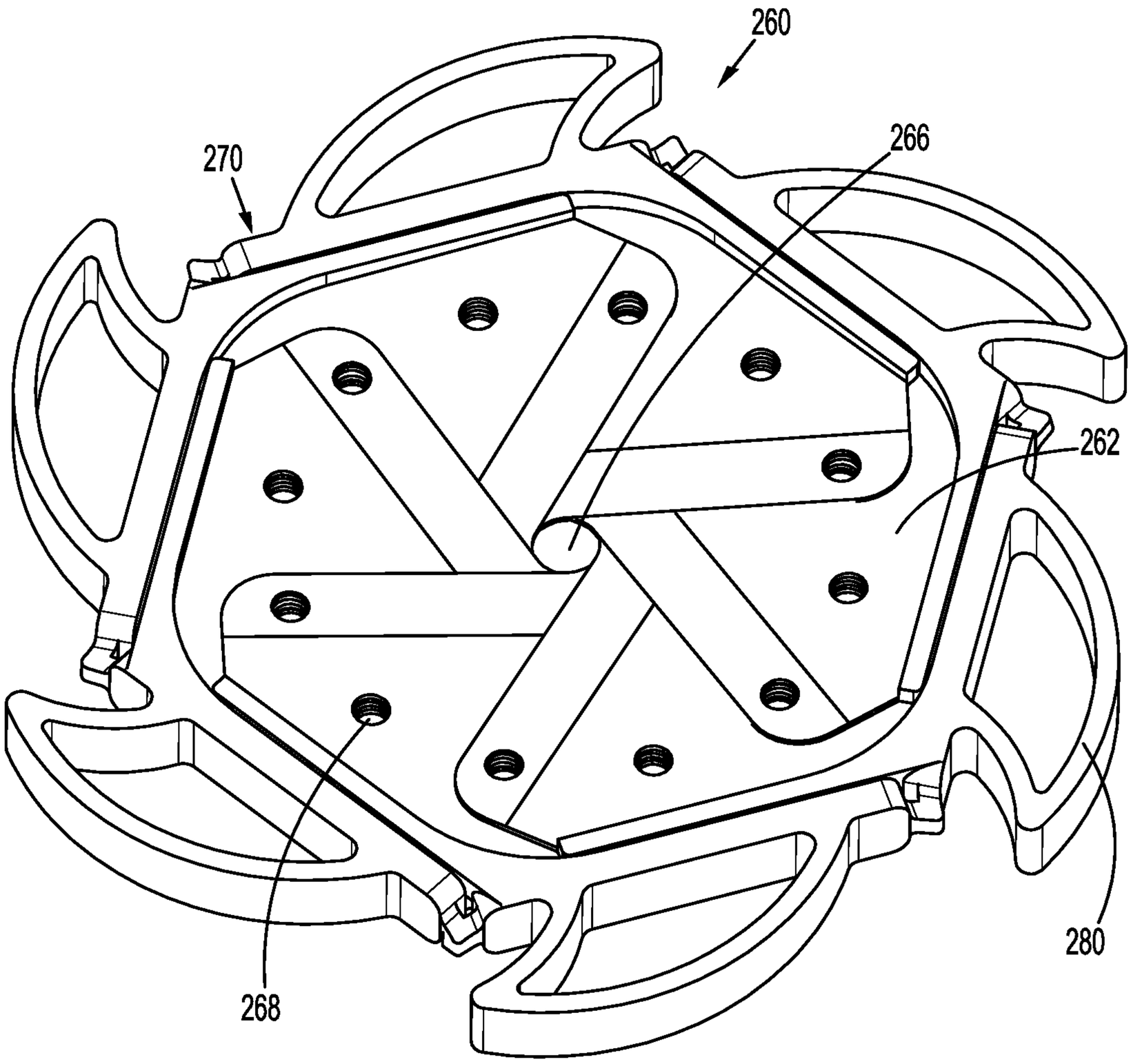
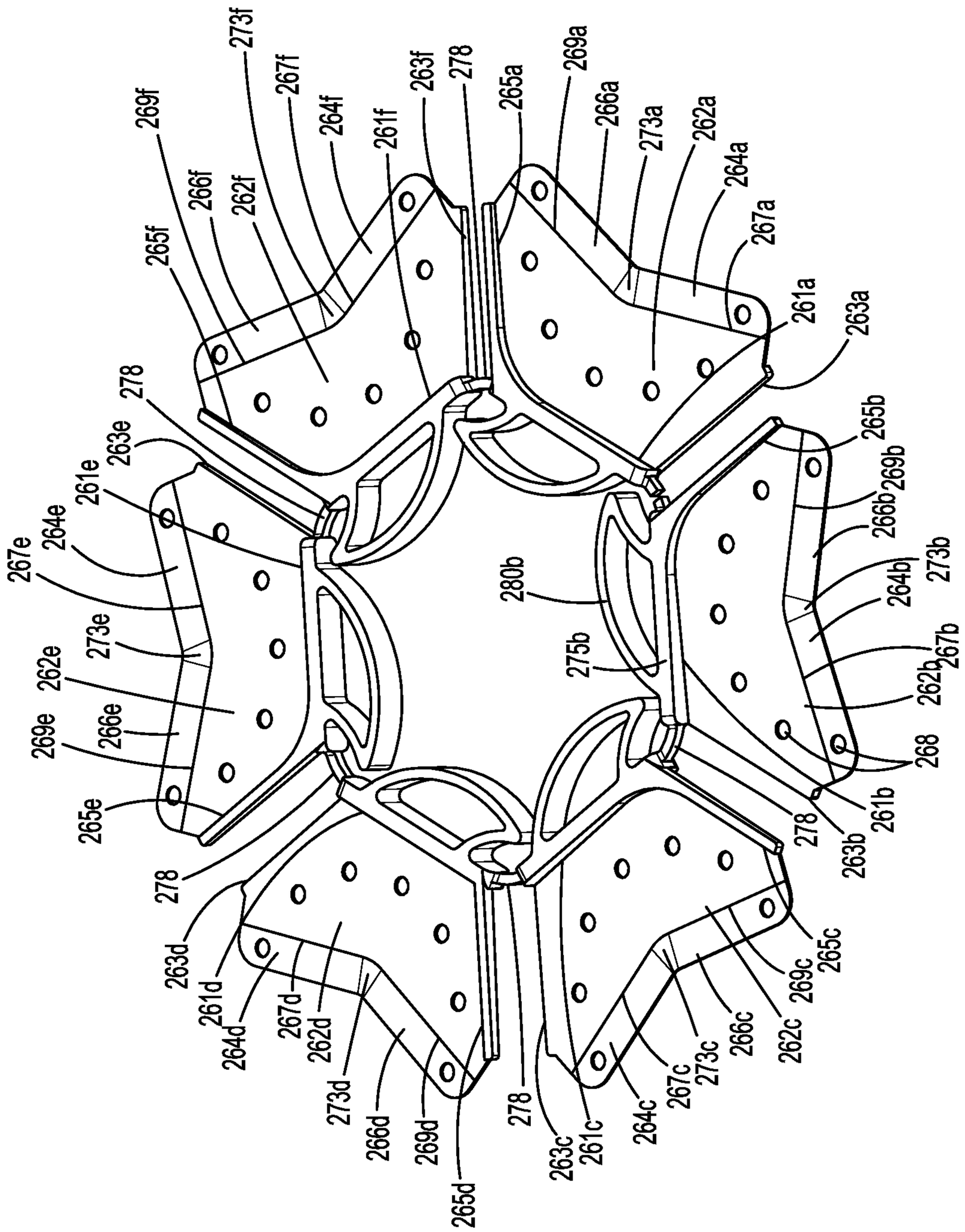


FIG. 10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263e
261e
264e
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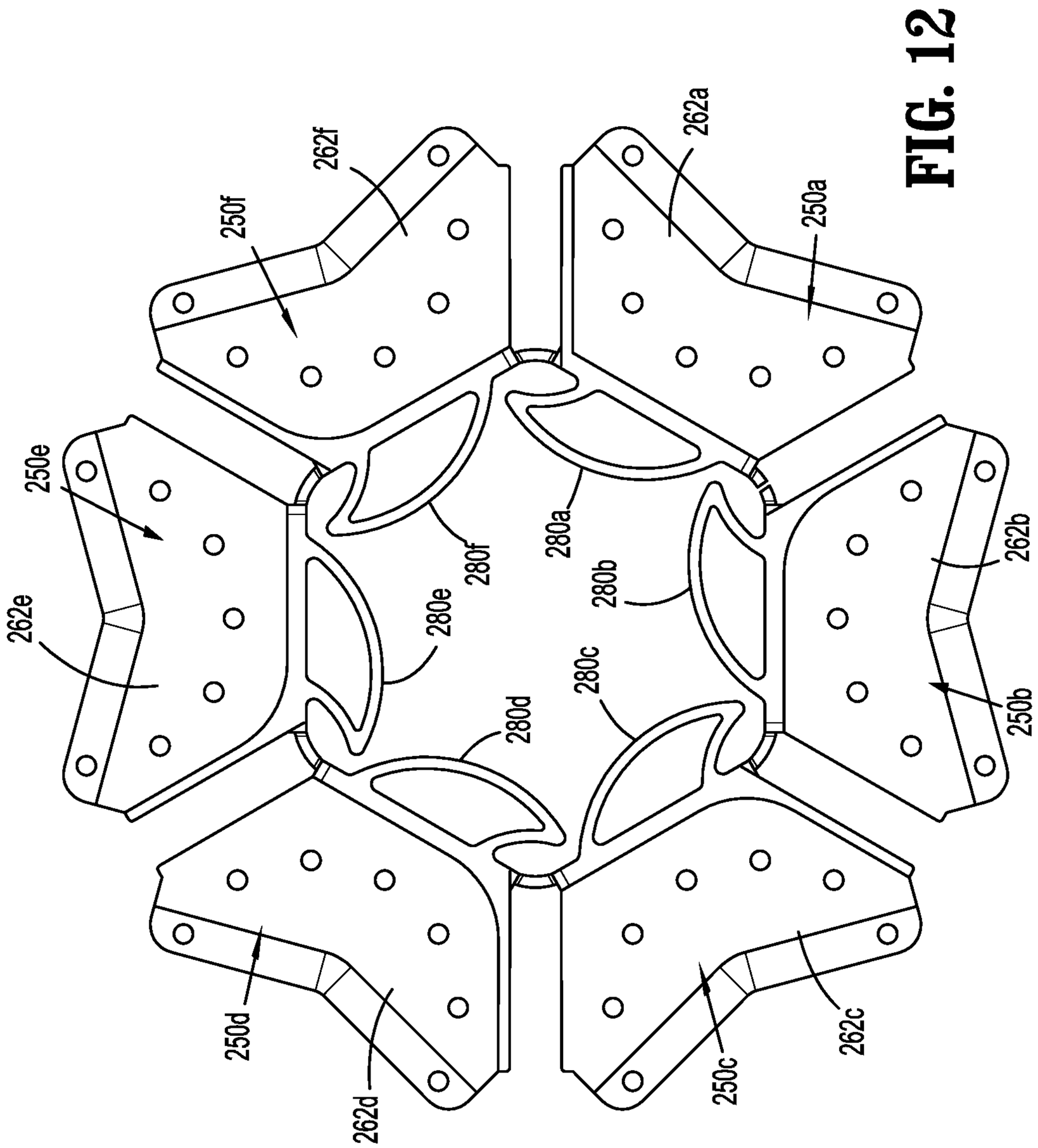
273e
262e
269e
266e
265e
278
280b
275b
265b
269b
266b
273b
264b
267b
262b
268
261b
278
263b
263d
261d
264d
267d
262d
273d
266d
269d
265d
278
263c
261c
264c
267c
273c
266c
262c
269c
265c

FIG. 11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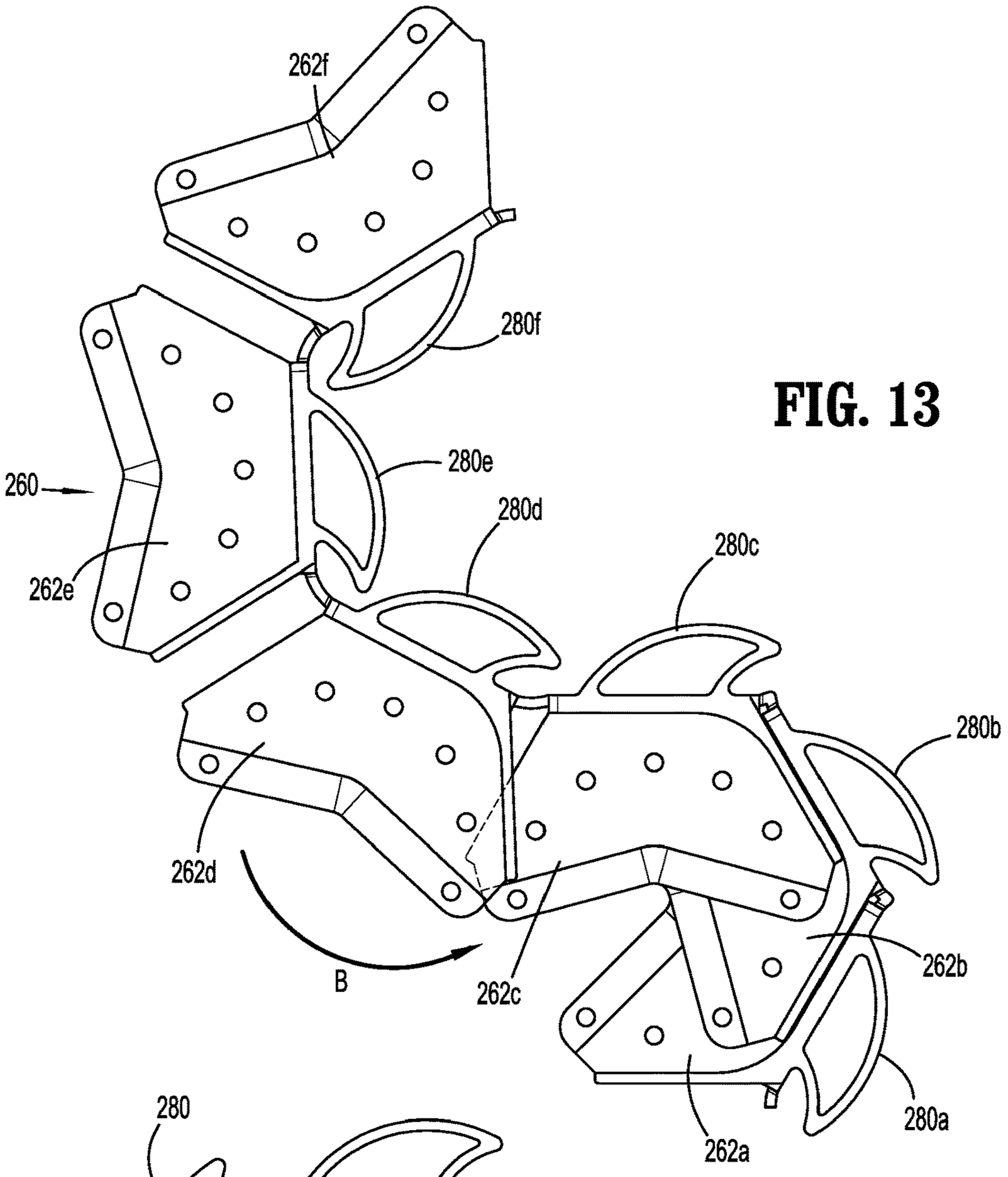
250d
262d
250c
262c

FIG. 12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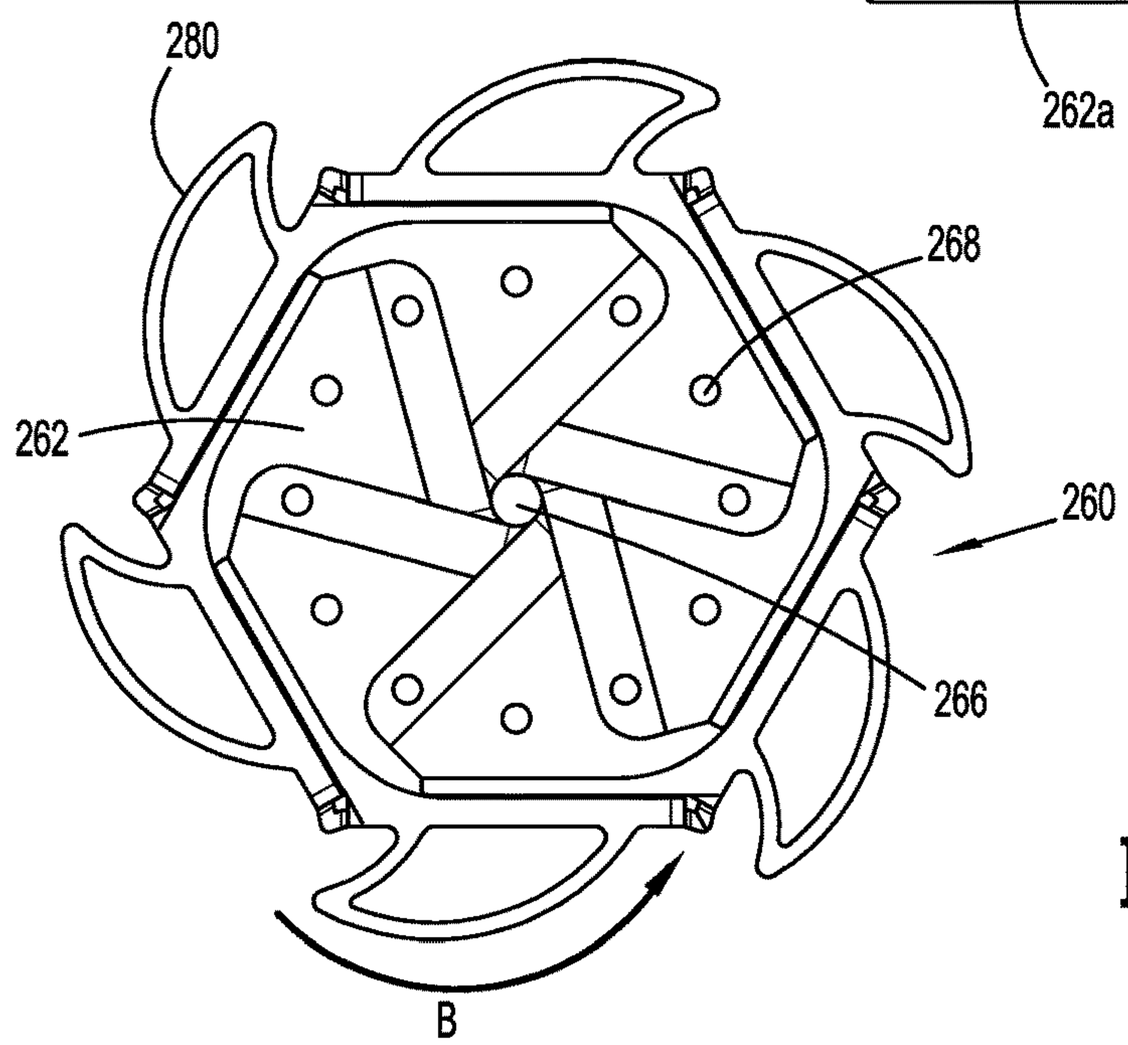
262c
262b
262a
B

FIG. 13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262
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266
B

FIG. 14

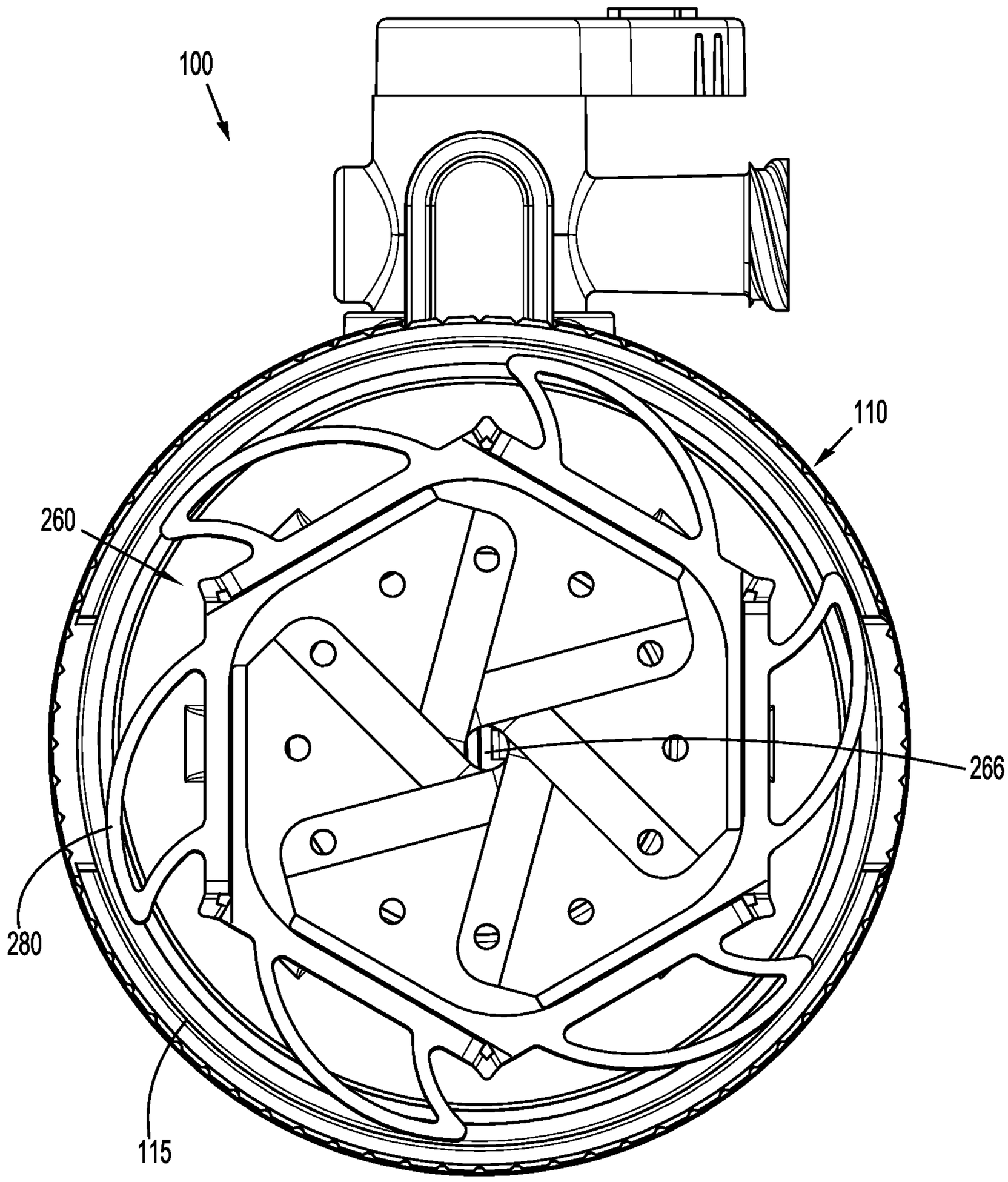

FIG. 15

INSTRUMENT SEAL FOR SURGICAL ACCESS ASSEMBLY

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation of U.S. patent application Ser. No. 16/823,503, filed on Mar. 19, 2020, the entire contents of which are incorporated by reference herein.

FIELD

The present disclosure relates generally to access assemblies including seals for minimally invasive surgery. More particularly, the present disclosure relates to instrument seals for surgical access assemblies.

BACKGROUND

In order to facilitate minimally invasive surgery, a working space must be created at a surgical site. An insufflation fluid, typically CO_2, is introduced into the abdomen of the patient to create an inflated state called pneumoperitoneum. Surgical access assemblies are utilized to allow the introduction of surgical instrumentation and endoscopes (or other visualization tools). These surgical access assemblies maintain the pressure for the pneumoperitoneum, as they have one or more seals that adapt to the surgical instrumentation. Typically, a "zero-seal" in the surgical access assembly seals the surgical access assembly in the absence of a surgical instrument in the surgical access assembly, and an instrument seal seals around a surgical instrument that has been inserted through the surgical access assembly.

The breadth of surgical instrumentation on the market today requires a robust seal capable adjusting to multiple sizes and withstanding multiple insertions and withdrawals of surgical instrumentation. Some of the surgical instrumentation can include sharp edges that can tear or otherwise damage seals. Therefore, it would be beneficial to have an access assembly with improved seal durability.

SUMMARY

In an embodiment, a surgical access assembly includes a housing, a tubular member extending from the housing, and a valve assembly disposed in the housing. The valve assembly includes a centering mechanism, a guard assembly, and an instrument seal. The centering mechanism has a central opening. The guard assembly has a central orifice that is alignable with the central opening of the centering mechanism. The guard assembly is disposed on a first side of the centering mechanism. The instrument seal includes a central hole alignable with the central opening of the centering mechanism and is disposed on a second side of the centering mechanism opposite the first side of the centering mechanism and proximate the tubular member. The instrument seal includes petals that are arranged such that a portion of one petal covers a portion of a first adjacent petal and is covered by a portion of a second adjacent petal.

The surgical access assembly may also include a retainer having first and second rings. The first ring may be disposed on the first side of the centering mechanism and the second side may be disposed on the second side of the centering mechanism. The retainer may sandwich the centering mechanism between the guard assembly and the instrument seal. The first ring may include pins extending therefrom and the second ring may include openings for receiving the pins therein.

The central opening of the centering mechanism may be circumscribed by a lip with pores extending therethrough, the guard assembly may include a ring with bores extending therethrough, and the instrument seal may include holes extending therethrough. The pins of the first ring may extend through the bores of the guard assembly, the pores of the centering mechanism, and the holes of the instrument seal to maintain the guard assembly, the centering mechanism, and the instrument seal in an aligned relationship. The pins of the first ring may be received in the openings of the second ring.

The instrument seal may have a frame that defines the central hole. The petals may be flexibly coupled to the frame. The petals may be coupled to the frame with living hinges.

In embodiments, a surgical access assembly has a housing, a tubular member extending from the housing, and a valve assembly disposed in the housing. The valve assembly includes a guard assembly with a central orifice and an instrument seal having a central hole aligned with the central orifice of the guard assembly. The instrument seal includes a frame with petals that are flexibly coupled to the frame. The instrument seal has an unfolded configuration defined by the petals extending away from a center of the frame and a folded configuration defined by the petals folded towards the central hole of the instrument seal such that each petal at least partially overlaps an adjacent petal such that the petals interlock.

The folded configuration of the instrument seal may define a diameter of the central hole that is configured to seal against a surgical instrument.

The petals may be flexibly coupled to the frame with living hinges.

The folded configuration of the instrument seal may allow the petals to flex relative to the frame while the frame may remain axially stationary relative to the housing.

The valve assembly may include a centering mechanism with a central opening. The guard assembly may be disposed on a first side of the centering mechanism and the instrument seal may be disposed on a second side of the centering mechanism that is opposite the first side.

The valve assembly may also include a retainer with first and second rings. The first ring may be disposed on the first side of the centering mechanism and the second ring may be disposed on the second side of the centering mechanism. The retainer may sandwich the centering mechanism between the guard assembly and the instrument seal.

The first ring of the retainer may include pins and the second ring of the retainer may include openings for receiving the pins. The pins of the first ring may be insertable through bores of the guard assembly, pores of the centering mechanism, and holes of the instrument seal to maintain the guard assembly, the centering mechanism, and the instrument seal in an aligned relationship.

In another embodiment, a surgical access assembly has a housing, a tubular member extending from the housing, and a valve assembly disposed in the housing. The valve assembly includes a centering mechanism with a central opening and an instrument seal in an abutting relationship with the centering mechanism. The instrument seal has a frame and petals. A first end of each petal is flexibly coupled to an outer surface of the frame and a second end of each petal is repositionable between a first position where the second end is outside a perimeter of the frame and a second position

where the second end is inside the perimeter of the frame. Each petal partially overlaps an adjacent petal such that the petals interlock.

The instrument seal may have a central hole defined by the second position of the petals. The central hole may define a diameter configured to seal against a surgical instrument. The central hole of the instrument seal may be alignable with the central opening of the centering mechanism.

The valve assembly may also include first and second rings. The first ring may be disposed adjacent the centering mechanism and the second ring may be disposed adjacent the instrument seal. The centering mechanism and the instrument seal may be sandwiched between the first and second rings.

The first ring may have pins extending therefrom and the second ring may have openings for receiving the pins therein.

The valve assembly may also include a guard assembly with a central orifice. The guard assembly may be disposed between the first ring and the centering mechanism.

In a further embodiment, a surgical access assembly includes a housing, a tubular member extending from the housing, and an instrument seal disposed in the housing. The instrument seal has a frame with a plurality of frame arms. Each frame arm of the plurality of frame arms is flexibly coupled to at least one other frame arm of the plurality of frame arms. The instrument seal also includes a plurality of petals corresponding to the plurality of frame arms. The plurality of petals is arranged such that a portion of a first petal of the plurality of petals covers a portion of a first adjacent petal of the plurality of petals and is covered by a portion of a second adjacent petal of the plurality of petals. Each petal of the plurality of petals is flexibly coupled to the corresponding frame arm of the plurality of frame arms. The instrument seal further includes a plurality of fins flexibly coupled to the plurality of frame arms. Each fin of the plurality of fins is biased away from the corresponding frame arm of the plurality of frame arms. The plurality of fins is configured to engage an inner surface of the housing.

The plurality of fins may be configured to urge the instrument seal towards a center of the housing.

Movement of the instrument seal relative to a central longitudinal axis of the housing may compress one or more of the fins of the plurality of fins.

The instrument seal may further include a central hole aligned with a central longitudinal axis of the housing. The central hole may be configured to seal against a surgical instrument.

The surgical access assembly may further include a guard assembly with a central orifice. The guard assembly may be disposed on a first side of the instrument seal.

The surgical access assembly may further include a retainer. The retainer may have first and second discs sandwiching the guard assembly and the instrument seal therebetween.

The instrument seal may include orifices extending through each petal of the plurality of petals and the guard assembly may include bores extending therethrough.

The first disc may include pins and the second disc may include openings for receiving the pins. The pins may be insertable through the bores and the orifices to maintain the guard assembly and the instrument seal in an aligned relationship.

Each petal of the plurality of petals may be adapted to flex relative to the frame while the frame remains axially stationary relative to the housing.

BRIEF DESCRIPTION OF DRAWINGS

Embodiments of an instrument seal are disclosed herein with reference to the drawings, wherein:

FIG. **1** is a perspective view of a surgical access assembly according to an embodiment of the present disclosure;

FIG. **2** is a cross-sectional view of the surgical access assembly of FIG. **1** taken along section line **2-2** of FIG. **1**;

FIG. **3** is a top perspective view of an instrument seal in an unfolded configuration according to an embodiment of the present disclosure;

FIG. **4** is a top plan view of the instrument seal of FIG. **3**;

FIG. **5** is a side elevational view of the instrument seal of FIG. **4**;

FIG. **6** is a top perspective view of the instrument seal of FIG. **4** in a partially folded configuration;

FIG. **7** is a top perspective view of the instrument seal of FIG. **4** in a fully folded configuration illustrating the folding sequence of the petals;

FIG. **8** is a bottom perspective view of a valve assembly according to an embodiment of the present disclosure;

FIG. **9** is an exploded view, with parts separated, of the valve assembly of FIG. **8** including a centering mechanism, a guard assembly, a retainer, and the instrument seal of FIG. **3**;

FIG. **10**. is a top perspective view of an instrument seal according to an alternate embodiment of the present disclosure;

FIG. **11** is a top perspective view of the instrument seal of FIG. **10** in an unfolded configuration;

FIG. **12** is a top plan view of the instrument seal of FIG. **11** with a link severed;

FIG. **13** is a top plan view of the instrument seal of FIG. **12** in a partially folded configuration illustrating the folding sequence of the petals;

FIG. **14** is a top plan view of the instrument seal of FIG. **12** in a fully folded configuration illustrating the folding sequence of the petals; and

FIG. **15** is a top cross-sectional view of an instrument housing of the surgical access assembly taken along section line **15-15** of FIG. **1** showing the placement of the instrument seal of FIG. **10** disposed therein.

DETAILED DESCRIPTION

Embodiments of the presently disclosed instrument seal for a surgical access assembly will now be described in detail with reference to the drawings wherein like numerals designate identical or corresponding elements in each of the several views. As is common in the art, the term "proximal" refers to that part or component closer to the user or operator, i.e. surgeon or physician, while the term "distal" refers to that part or component farther away from the user.

Surgical access assemblies are employed during minimally invasive surgery, e.g., laparoscopic surgery, and provide for the sealed access of surgical instruments into an insufflated body cavity, such as the abdominal cavity. The surgical access assemblies of the present disclosure include an instrument valve housing mounted on a cannula tube, and include an obturator (not shown) inserted through the instrument valve housing and cannula tube. The obturator can have a blunt distal end, or a bladed or non-bladed penetrating distal end and can be used to incise the abdominal wall so that the surgical access assembly can be introduced into the abdomen. The handle of the obturator can engage or selectively lock into the instrument valve housing of the surgical access assembly.

Surgical access assemblies with a trocar obturator are employed to tunnel through an anatomical structure, e.g., the abdominal wall, either by making a new passage through the structure or by passing through an existing opening through the anatomical structure. Once the surgical access assembly with the trocar has tunneled through the anatomical structure, the trocar obturator is removed, leaving the surgical access assembly in place. The instrument valve housing of the surgical access assembly includes valves that prevent the escape of insufflation fluid from the body cavity, while also allowing surgical instruments to be inserted into the cavity and minimizing the escape of insufflation fluid.

In various embodiments, a bladeless optical trocar obturator may be provided that permits separation of tissue planes in a surgical procedure and visualization of body tissue fibers as they are being separated, thereby permitting a controlled traversal across a body wall. In other embodiments, the trocar obturator may be bladeless without being optical, e.g., without providing contemporaneous visualization thereof through the distal tip of the obturator. The bladeless obturator may be provided for the blunt dissection of the abdominal lining during a surgical procedure.

Various trocar obturators suitable for use with the surgical access assemblies of the present disclosure are known and include, for example, bladed, bladeless, blunt, optical, and non-optical. For a detailed description of the structure and function of exemplary trocar assemblies, including exemplar trocar obturators and exemplar cannulas, please refer to PCT Publication No. WO 2016/186905 ("the '905 publication"), the content of which is hereby incorporated by reference herein in its entirety.

With initial reference now to FIG. **1**, a surgical access assembly according to aspects of the present disclosure is shown generally as cannula assembly **100**. The cannula assembly **100** includes a cannula **102** and an instrument valve housing **110** secured to the cannula **102**. For a detailed description of an exemplary cannula assembly, please refer to the '905 publication.

With additional reference to FIG. **2**, the instrument valve housing **110** of the cannula assembly **100** includes an upper housing section **112**, a lower housing section **114**, and an inner housing section **116**. The upper, lower, and inner housing sections **112**, **114**, **116** are configured to support a valve assembly **120** on a proximal end of the cannula **102**. More particularly, the inner housing section **116** is secured between the upper and lower housing sections **112**, **114**, and the valve assembly **120** is received between the inner and lower housing sections **116**, **114**. The upper and lower housing sections **112**, **114** of the instrument valve housing **110** may be selectively attachable to, and detachable from, the inner housing section **116**. The lower housing section **114** may be releasably or permanently attached to a cannula tube **104** of the cannula assembly **102**. In embodiments, either or both of the upper and lower housing sections **112**, **114** of the instrument valve housing **110** may include knurls, indentations, tabs, or be otherwise configured to facilitate engagement by a clinician.

The cannula assembly **100** may also include features for the stabilization of the surgical access assembly. For example, the distal end of the cannula tube **104** can carry a balloon anchor or another expandable member that engages the abdomen from the interior side. For example, see U.S. Pat. No. 7,300,448, the entire disclosure of which is hereby incorporated by reference herein. A feature on the opposite side of the abdominal wall can be used to further stabilize the surgical access assembly, such as adhesive tabs or adjustable foam collars.

The upper, lower, and inner housing sections **112**, **114**, **116** of the instrument valve housing **110** define a longitudinal passage **111** for receipt of a surgical instrument (not shown). The valve assembly **120** is supported within the instrument valve housing **110** to provide sealed passage of the surgical instrument through the cannula assembly **100**.

Referring now to FIGS. **3-5**, an instrument seal **160**, according to an embodiment of the present disclosure, is illustrated. The instrument seal **160**, as illustrated, includes a hexagonal frame **170** that may be integrally formed (i.e., monolithic or unitary) or may be formed from six discrete segments that are joined together to form the frame **170**. The segments may be joined to each other by welding, adhesives, mechanical joints, or other techniques as known in the art. The sides or segments **172***a-f* of the frame **170** form a boundary that defines a passage **178** having a center through the instrument seal **160**. The center of the passage **178** is coaxial with a central hole **176** of the instrument seal **160**. A corresponding number of petals **162** are attached to the frame **170**. Although depicted with six petals **162***a-f* coupled to a hexagonal frame **170**, the instrument seal may include a frame with more sides or discrete segments and a corresponding number of petals (e.g., 8). Alternatively, the presently disclosed instrument seal may include a frame with fewer sides or discrete segments and a corresponding number of petals (e.g., 4). The frame **170** and the petals **162***a-f* may be fabricated from a polyisoprene, a liquid silicone rubber, or another suitable polymeric material. The instrument seal **160** may be molded, stamped, or formed in any other suitable manner. Each petal **162***a-f* is flexibly coupled to a side **172***a-f* of the frame **170** via a living hinge **174***a-f*. Further, as shown in FIGS. **3** and **5**, each petal **162***a-f* is attached to the corresponding side **172***a-f* of the frame **170** via the living hinge **174***a-f* such that each petal **162***a-f* and the corresponding living hinge **174***a-f* define an acute angle with respect to either a top or bottom surface of the side or segment of the frame **170**. The acute angle may be in the range of about 3° to about 10°. By angling each petal **162***a-f* relative to the top or bottom surface of the frame **170**, interweaving the petals **162***a-f* of the instrument seal **160** is easier than if each petal **162***a-f* was parallel with the top or bottom surface of the frame **170**.

Each petal **162***a-f* is a five sided main panel **150***a-f* with holes **168** extending therethrough. Although shown with five sides, each main panel **150***a-f* may have more or less than five sides. A first or connection side **161***a-f* is coupled to a side or segment **172***a-f* of the frame **170** with the corresponding living hinge **174***a-f*. This arrangement allows the petal **162***a-f* to be transitioned from an unfolded configuration (FIG. **3**) to a folded configuration (FIG. **7**). Each living hinge **174***a-f* may be formed from the same material as the frame **170** and the petals **162***a-f* or may be formed from another suitable polymeric material. In the unfolded configuration, each petal **162***a-f* extends away from an outer surface of the frame **170** outside a perimeter defined by the frame **170**. In the folded configuration, each petal **162***a-f* is bounded by the frame **170** and is within the perimeter defined by the frame **170**. Each main panel **150***a-f* has angled second and third sides **163***a-f*, **165***a-f* that extend from the connection side **161***a-f* in a divergent manner. Fourth and fifth sides **167***a-f*, **169***a-f* of main panels **150***a-f* interconnect the angled second and third sides **163***a-f*, **165***a-f*. The fourth and fifth sides **167***a-f*, **169***a-f* of the main panels **150***a-f* of each petal **162***a-f* have equal lengths and are angled towards the corresponding connection side **161***a-f* such that they meet a point that would bisect the connection side **161***a-f*. Additionally, the fourth and fifth sides **167***a-f*,

169*a-f* are oriented such that they define an angle between 120° and 160°. First and second extenders **164***a-f*, **166***a-f* are attached to the fourth and fifth sides **167***a-f*, **169***a-f*. Each extender **164***a-f*, **166***a-f* includes a hole **168** extending therethrough. The first and second extenders **164***a-f*, **166***a-f* have equal lengths and meet at wedges **173***a-f* that also is located at a point that would bisect the connection side **161***a-f*. The extenders **164***a-f*, **166***a-f* and the main panels **150***a-f* of each petal **162***a-f* bend at a midpoint between the second and third sides **163***a-f*, **165***a-f* of each petal **162***a-f* such that, when viewed from the end (i.e., from the extenders towards the connection side) (see FIG. **5**), the petal **162***a-f* has a slight curvature of about 3° to about 10°. The combination of the petals' **162***a-f* curvature, the angled relationship between each petal **162***a-f* and the side or segment **172***a-f* of the frame **170**, and the material of construction, facilitates folding the petals **162***a-f* in an interlocking pattern when transitioning the instrument seal **160** from the unfolded configuration to the folded configuration.

With reference now to FIGS. **3**, **6**, and **7**, transitioning the instrument seal **160** from the unfolded configuration (FIG. **3**) to the folded configuration (FIG. **7**) includes folding the petals **162***a-f* sequentially such that they interlock by having each petal **162***a-f* partially overlap an adjacent petal **162***a-f*. Initially, as seen in FIG. **3**, the instrument seal **160** is in the unfolded configuration with the extenders **164***a-f*, **166***a-f* of the petals **162***a-f* facing away from the frame **170**. Each petal **162***a-f* is folded along a line defined by the associated living hinge **174***a-f* which defines an angle between the connection side **161***a-f* of the respective petal **162***a-f* and the corresponding side or segment **172***a-f* of the frame **170**. Thus, the intersection of the connection side **161***a-f* and the corresponding third side **165***a-f* of each petal **162***a-f* is closer to the side or segment **172***a-f* of the frame **170** than the intersection of the connection side **161***a-f* and the second side **163***a-f* of each petal **162***a-f* is to the side or segment **172***a-f* of the frame **170**. The petals **162***a-f* are folded sequentially in the direction of arrows "A" such that all of the petals **162***a-f* are in a near vertical orientation (FIG. **6**). In this arrangement, the second side **163***a-f* of one petal **162***a-f* partially overlaps the third side **165***a-f* of the adjacent petal **162***a-f*. In particular, as illustrated in FIG. **6**, the third side **165***a* of the first petal **162***a* partially overlaps the second side **163***f* of the sixth petal **162***f*, the third side **165***b* of the second petal **162***b* partially overlaps the second side **163***a* of the first petal **162***a*, the third side **165** of the third petal **162***c* partially overlaps the second side of the second petal **162***b*, the third side **165***d* of the fourth petal **162***d* partially overlaps the second side **163***c* of the third petal **162***c*, the third side **165***e* of the fifth petal **162***e* partially overlaps the second side **163***d* of the fourth petal **162***d*, the third side **165***f* of the sixth petal **162***f* partially overlaps the second side **163***e* of the fifth petal **162***e*, and the third side **165***a* of the first petal **162***a* partially overlaps the second side **163***f* of the sixth petal **162***f*. This defines a partially folded configuration of the instrument seal **160**. Subsequently, the user continues to fold the petals **162***a-f* towards a center of the frame **170** in the direction of arrows "A" while maintaining the overlapping arrangement between the second and third sides **163***a-f*, **165***a-f* of the petals **162***a-f*. Once all the petals **162***a-f* are folded such that they are substantially flush with a top surface of the frame **170**, the overlapping arrangement of the second and third sides **163***a-f*, **165***a-f* of the petals **162***a-f* maintains the petals **162***a-f* in contact with one another thereby maintaining the instrument seal **160** in the folded configuration. Further, once all the petals **162***a-f* are folded over, the holes **168** of the petals **162***a-f* are aligned thereby allowing pins **186** of a retainer **180** to pass therethrough as will be discussed in detail hereinbelow. As seen in FIG. **7**, the folded configuration of the instrument seal **160** defines a central hole **176** for slidably receiving a surgical instrument therethrough. The central hole **176** may have a diameter between 0.025 inches to 0.100 inches (i.e., 0.0635 cm to 0.254 cm).

With reference now to FIGS. **2**, **8**, and **9**, the valve assembly **120**, according to an embodiment of the present disclosure, is illustrated. The valve assembly **120** is located in the instrument valve housing **110** and includes a centering mechanism **130**, a guard assembly **140**, the instrument seal **160**, and a retainer **180**. The centering mechanism **130** of the valve assembly **120** permits radial movement of the valve assembly **120** relative to a central longitudinal axis "X" of the instrument valve housing **110** in response to insertion of a surgical instrument (not shown) through the valve assembly **120** and radial movement of the surgical instrument relative to the central longitudinal axis "X". In the absence of a surgical instrument or in the absence of radial movement of a surgical instrument relative to the central longitudinal axis "X", the centering mechanism **130**, as will be described in detail hereinbelow, returns the valve assembly **120** to a generally centered position such that a central opening **133** of the centering mechanism **130** and the central longitudinal axis "X" are coaxial. The guard assembly **140** protects the instrument seal **160** during insertion and withdrawal of a surgical instrument through the instrument seal **160**, which, as discussed hereinabove, provides for sealed passage of the surgical instrument through the instrument valve housing **110**. The retainer **180** includes first and second rings **182**, **184** that are located on opposing sides of the centering mechanism **130** for maintaining relative positions of the guard assembly **140**, the centering mechanism **130**, and the instrument seal **160**. Additionally, the retainer maintains **180** an aligned relationship of the guard assembly **140**, the centering mechanism **130**, and the instrument seal **160**. In particular, the first ring **182** of the retainer **180** includes pins **186** that extend from a bottom surface of the first ring **182** while the second ring **184** of the retainer **180** includes complementary openings **188** for receiving the pins **186** of the first ring **182**. The pins **186** may be releasably engaged with the openings **188** or the pins **186** may be secured within the openings **188** by welding, adhesives, friction fit, or other techniques as are known in the art. The pins **186** are insertable through bores **148** of the guard assembly **140**, pores **138** of the centering mechanism **130**, the holes **168** of the instrument seal **160**, and the openings **188** of the second ring **184** of the retainer **180**. This arrangement aligns the relative positions of the guard assembly **140**, the centering mechanism **130**, and the instrument seal **160**. Although illustrated with pins **186** extending from the first ring **182** towards openings **188** in the second ring **184**, the retainer may have the pins located on the second ring and the openings on the first ring. Alternatively, the first and second rings may have an alternating arrangement of pins and openings that are complementary such that the pins of one of the rings align with openings of the other of the rings allowing the rings to be attached to one another and define the retainer. The first ring **182** defines a central opening **185** extending therethrough and the second ring **184** defines a central opening **187** extending therethrough.

The centering mechanism **130** of the instrument valve housing **110** is configured to maintain the valve assembly **120** centered within the instrument valve housing **110**. More particularly, the centering mechanism **130** includes an outer

annular ring **132**, an inner annular ring **134**, and a bellows **136** disposed between the outer annular ring **132** and the inner annular ring **134**. As shown in FIG. **2**, the outer annular ring **132** is received between the inner housing section **116** and the lower housing section **114** to retain the centering mechanism **130** within the instrument valve housing **110**. The inner annular ring **134** supports the guard assembly **140**. For a detailed description of the structure and function of an exemplary centering mechanism, please refer to U.S. Pat. No. 6,702,787, the content of which is incorporated herein by reference in its entirety.

The guard assembly **140** may be formed from a sheet of a plastic or other suitable polymeric material by stamping with a tool that forms a ring **142** and blades **144***a-d*. The ring **142** surrounds the blades **144***a-d* and includes bores **148** extending therethrough for slidably receiving the pins **186** of the first ring **182** of the retainer **180**. Further, when the valve assembly **120** is assembled, the guard assembly **140** is positioned between one side of the centering mechanism **130** and the first ring **182** of the retainer **180**. The blades **144***a-d* are configured to flex towards the centering mechanism **130** in response to insertion of a surgical instrument (not shown) through a central orifice **146** of the guard assembly **140** and return to a generally planar configuration (i.e., parallel with the ring) once the surgical instrument is removed. The blades **144***a-d* extend towards a center of the ring **142** and define the central orifice **146** which has a diameter greater than an outside diameter of the surgical instrument.

During a surgical procedure utilizing cannula assembly **100**, a surgical instrument (not shown) is introduced into the instrument valve housing **110** through the longitudinal passage **111** in the upper, lower, and inner housing sections **112**, **114**, **116**. As described above, the distal end of the surgical instrument engages one or more of the blades **144***a-d* of the guard assembly **140** causing the blades **144***a-d* to flex downward into contact with the petals **162***a-f* of the instrument seal **160**. This causes the central hole **176** of the instrument seal **160** to dilate such that the diameter of the central hole **176** is sufficiently large enough to accommodate passage of the surgical instrument therethrough. The guard assembly **140** minimizes damage to the instrument seal **160** during insertion and/or removal of the surgical instrument through the valve assembly **120**. The guard assembly **140** operates to protect the instrument seal **160** and minimizes tearing or other damage as the surgical instrument is received through and withdrawn from the instrument seal **160**.

With reference now to FIGS. **10-12**, an alternate embodiment of an instrument seal is illustrated and identified generally as instrument seal **260**. Instrument seal **260** may be a direct replacement for both the instrument seal **160** and the centering mechanism **130** in valve assembly **120** as illustrated in the previous embodiment. The instrument seal **260**, as illustrated, includes a frame **270** having six sides **272***a-f*. The frame **270** may have fewer sides (e.g., 4) or more sides (e.g., 8). Each side **272***a-f* is generally rectangular and extends along a length of a corresponding petal **262***a-f*. The number of petals **262** is equal to the number of sides **272** of the frame **270**. Links **278** extend between adjacent side **272** defining a plurality of living hinges. In particular, links **278** define living hinges between sides **272***a-b*, between sides **272***b-c*, between sides **272***c-d*, between sides **272***d-e*, and between sides **272***e-f*. A gap is defined between sides **272***a* and **272***f* allowing sides **272***a* and **272***f* to move relative to each other. This arrangement facilitates folding the seal **270** thereby transitioning the seal **270** from the unfolded or initial configuration as shown in FIG. **12** to the folded or final configuration as shown in FIG. **10**. Since sides **272***a* and **272***f* have a gap therebetween and lack a living hinge, one of sides **272***a* or **272***f* may be repositioned without disturbing the position of the other of sides **272***a* or **272***f*. The instrument seal **260** also includes a plurality of fins **280***a-f* that extends from respective sides **272***a-f* on the side of the side **272***a-f* opposite that of the petals **262***a-f*. Each fin **280***a-f* is a flexible and resilient structure that is normally biased towards a center of the unfolded instrument seal **260** (FIG. **12**) and normally biased away from the center of the folded instrument seal **260** (FIG. **14**). The biasing and resilience of the fins **280***a-f* acts to center the instrument seal **260** when the instrument seal is positioned in the valve housing **110** (FIG. **15**) as will be discussed in further detail hereinbelow.

Each petal **262***a-f* is a five sided main panel **250***a-f* with holes **268** extending therethrough. Although shown with five sides, each main panel **250***a-f* may have more or less than five sides. A first or connection side **261***a-f* is coupled to a side or segment **272***a-f* of the frame **270**. In the unfolded configuration (FIGS. **11** and **12**), each petal **262***a-f* extends away from an outer surface of the frame **270** outside a perimeter defined by the frame **270**. In the folded configuration (FIGS. **10** and **14**), each petal **262***a-f* is bounded by the frame **270** and is within the perimeter defined by the frame **270**. Each main panel **250***a-f* has angled second and third sides **263***a-f*, **265***a-f* that extend from the connection side **261***a-f* in a divergent manner. Fourth and fifth sides **267***a-f*, **269***a-f* of main panels **250***a-f* interconnect the angled second and third sides **263***a-f*, **265***a-f*. The fourth and fifth sides **267***a-f*, **269***a-f* of the main panels **250***a-f* of each petal **262***a-f* have equal lengths and are angled towards the corresponding connection side **261***a-f* such that they meet a point that would bisect the connection side **261***a-f*. Additionally, the fourth and fifth sides **267***a-f*, **269***a-f* are oriented such that they define an angle between 120° and 160°. First and second extenders **264***a-f*, **266***a-f* are attached to the fourth and fifth sides **267***a-f*, **269***a-f*. Each extender **264***a-f*, **266***a-f* includes a hole **268** extending therethrough. The extenders **264***a-f*, **266***a-f* and the main panels **250***a-f* of each petal **262***a-f* bend at a midpoint between the second and third sides **263***a-f*, **265***a-f* of each petal **262***a-f* such that, when viewed from the end (i.e., from the extenders towards the connection side) (similar to FIG. **5**), the petal **62***a-f* has a slight curvature of about 5° to about 10°.

The first petal **262***a* is folded by pivoting the first side **272***a* and the first petal **262***a* about the living hinge defined by the link **278** that is disposed between the first and second sides **272***a*, **272***b* in the direction of arrow "B". As such, the first petal **262***a* partially overlaps the second petal **262***b*. Subsequently, the first and second petals **262***a*, **262***b* are pivoted by pivoting the second side **272***b* about the living hinge defined by the link **278** that is disposed between the second side **272***b* and the third side **272***c* such that the second petal **262***b* partially overlaps the third petal **262***c* (FIG. **13**). Next, the first, second, and third petals **262***a-c* are pivoted by pivoting the third side **272***c* about the living hinge defined by the link **278** that is disposed between the third side **272***c* and the fourth side **272***d* such that the third petal **262***c* partially overlaps the fourth petal **262***d*. Subsequently, the first, second, third, and fourth petals **262***a-d* are pivoted by pivoting the fourth side **272***d* about the living hinge defined by the link **278** that is disposed between the fourth side **272***d* and the fifth side **272***e* such that the fourth petal **262***d* partially overlaps the fifth petal **262***e*. The first, second, third, fourth, and fifth petals **262***a-e* are pivoted by pivoting the fifth side **272***e* about the living hinge defined by the link

278 that is disposed between the fifth side 272*e* and the sixth side 272*f* such that the fifth petal 262*e* partially overlaps the sixth petal 262*f* and the sixth petal 262*f* partially overlaps the first petal 262*a*. The fully folded seal 260 is illustrated in FIG. 14. All the folds occur in the direction identified by arrow "B".

After all the petals 262*a-f* are folded, a center orifice 266 is defined and is configured to engage an outer surface of a surgical instrument (not shown) inserted through the seal 260 such that the center orifice 266 surrounds the surgical instrument in a sealing manner to inhibit the passage of insufflation fluids and defines a fluid tight barrier. Further, once the petals 262*a-f* are folded over, the holes 268 of the petals 262*a-f* are aligned thereby allowing pins 186 of the retainer 180 to pass through the holes 268. In this embodiment, the pins 186 are insertable through bores 148 of the guard assembly 140, the holes 268 of the instrument seal, and the openings 188 of the second ring 184 of the retainer 180. This arrangement aligns the relative positions of the guard assembly 140 and the instrument seal 260. Although illustrated with pins 186 extending from the first ring 182 towards openings 188 in the second ring 184, the retainer may have the pins located on the second ring and the openings on the first ring. Alternatively, the first and second rings may have an alternating arrangement of pins and openings that are complementary such that the pins of one of the rings align with openings of the other of the rings allowing the rings to be attached to one another and define the retainer.

As each petal 262*a-f* at least partially overlaps a first adjacent petal 262 and is at least partially overlapped by a second adjacent petal 262, the petals 262*a-f* of the seal are interwoven. This interwoven arrangement of the petals 262*a-f* facilitates the seal 260 maintaining its shape during insertion and withdrawal of a surgical instrument through the center orifice 266. For example, with additional reference to FIG. 2, the seal 260 would replace the seal 160 and the centering mechanism 130. FIG. 15 illustrates the placement of the instrument seal 260 in vale housing 110 of the cannula assembly 100. During insertion of the surgical instrument through the valve housing 110 of the surgical access assembly 100, a shaft of the surgical instrument passes through the central opening 185 of the first ring 182, the central orifice 146 of the guard assembly 140, the center orifice 266 of the instrument seal 260, and the central opening 187 of the second ring 184. As the shaft of the surgical instrument passes through the center orifice 266 of the seal 260 during insertion, the petals 262*a-f* of the seal 260 flex towards the second ring 184 and surround an outer surface of the shaft of the surgical instrument providing a fluid tight barrier between the petals 262*a-f* of the seal 260 and the shaft of the surgical instrument. During withdrawal of the surgical instrument, the petals 262*a-f* of the seal 260 flex towards a proximal portion of the valve housing 110 in response to proximal movement of the shaft of the surgical instrument. The petals 262*a-f* of the seal 260 resiliently return to their initial or rest configuration (FIG. 10) once the shaft of the surgical instrument is removed from the center orifice 266 of the seal 260. Due to the petals 262*a-f* being interwoven, they return to their initial configuration. In the event that the petals 262*a-f* have slightly different rates of movement, the interwoven arrangement of the petals 262*a-f* results in the slowest moving petal 262 acting as a governor and limiting the rate of movement of the remaining petals 262. This tends to maintain contact between the petals 262*a-f* and the outer surface of the shaft of the surgical instrument thereby maintaining the fluid tight boundary of the seal 260 with respect to the surgical instrument during movement of the shaft relative to the seal 260.

Referring now to FIG. 15, the instrument seal 260 is positioned in the valve housing 110 and the fins 280*a-f* contact an inner wall 115 of the valve housing 110. In an initial state, the normal biasing force exerted by the fins 280*a-f* act to center the instrument seal 260 in the valve housing 110 such that the center orifice 266 is aligned with the central longitudinal axis "X" of the cannula assembly 100 (FIG. 2). When a surgical instrument is inserted through the valve housing 110 and the center orifice 266, any radial movement of the surgical instrument relative to the longitudinal axis "X" moves the instrument seal 260 in the same radial direction. This results in the center orifice 266 being radially offset from the central longitudinal axis "X". In particular, when the instrument seal 260 is moved radially, the fins 280*a-f* in the direction of movement are compressed more while the fins 280*a-f* on the opposing side a relaxed more. Thus, when the force is removed, the compressed fins 280*a-f* will move towards their initial position and return the instrument seal 260 to its at rest position where the center orifice 266 is aligned with the central longitudinal axis "X". It is contemplated that all of the fins 280*a-f* will be slightly compressed when the instrument seal 260 is disposed within the valve housing 110.

Each petal 262*a-f* is connected to a corresponding side 272*a-f* of the frame 270 along a first or connection side 261*a-f*. Each petal 262*a-f* also includes angled second and third sides 263*a-f*, 265*a-f* that extend from the corresponding connection side 261*a-f* in a divergent manner. Fourth and fifth sides 267*a-f*, 269*a-f* of each petal 262*a-f* interconnect the angled second and third sides 263*a-f*, 265*a-f*. The fourth and fifth sides 267*a-f*, 269*a-f* of the petals 262*a-f* have equal lengths and are angled towards the corresponding connection side 261*a-f* such that they meet at a point that would bisect the connection side 261*a-f*. The fourth and fifth sides are oriented such that they that they define an angle of 150°. The fourth and fifth sides may define an angle between about 120° and about 165°. First and second extenders 262*a-f*, 264*a-f* are attached to the fourth and fifth sides 267*a-f*, 269*a-f*. The first and second extenders 262*a-f*, 264*a-f* have equal lengths and meet at a taper 273*a-f* that also is located at a point that would bisect the corresponding connection side 261*a-f*.

It will be understood that various modifications may be made to the embodiments disclosed herein. Therefore, the above description should not be construed as limiting, but merely as exemplifications of particular embodiments. Those skilled in the art will envision other modifications within the scope and spirit of the claims appended hereto.

What is claimed is:

1. A surgical access assembly comprising:

a housing; and

an instrument seal disposed in the housing, the instrument seal including:

a frame having connected linear segments, the connected linear segments defining a polygonal configuration of the frame, and

a plurality of petals, each petal of the plurality of petals attached to a corresponding linear segment of the linear segments and defining an acute angle with respect to a top surface of the corresponding linear segment of the linear segments, the plurality of petals arranged such that a portion of one petal of the plurality of petals covers a portion of a first adjacent petal of the plurality of petals and is covered by a portion of a second adjacent petal of the plurality of

petals such that the plurality of petals define a central hole of the instrument seal.

2. The surgical access assembly of claim **1**, further including a bellows having a first side and a second side, the first side of the bellows facing a first side of the instrument seal.

3. The surgical access assembly of claim **2**, further including a first ring disposed on a second side of the instrument seal, a guard disposed on the second side of the bellows, and a second ring disposed adjacent to the guard, the guard, the bellows, and the instrument seal sandwiched between the first ring and the second ring.

4. The surgical access assembly of claim **3**, wherein the guard includes bores, the bellows includes pores, and the instrument seal includes peripheral holes.

5. The surgical access assembly of claim **4**, wherein one of the first ring or the second ring includes pins and the other one of the first ring or the second ring includes openings for receiving the pins, the pins insertable through the bores of the guard, the pores of the bellows, and the peripheral holes of the instrument seal to maintain the guard, the bellows, and the instrument seal in an aligned relationship.

6. The surgical access assembly of claim **1**, wherein the instrument seal has an unfolded configuration defined by the plurality of petals extending away from a center of the frame and a folded configuration defined by the plurality of petals folded towards a center of the instrument seal.

7. The surgical access assembly of claim **6**, wherein the folded configuration of the instrument seal allows the plurality of petals to flex relative to the frame while the frame remains axially stationary relative to the housing.

8. A surgical access assembly comprising:

a housing; and

an instrument seal having a central hole and a polygonal frame, the polygonal frame having a plurality of segments and a plurality of petals flexibly coupled to corresponding segments of the plurality of segments such that each petal of the plurality of petals defines an acute angle with respect to a top surface of the corresponding segment of the plurality of segments, the instrument seal having an unfolded configuration defined by the plurality of petals extending away from a center of the frame and a folded configuration defined by the plurality of petals folded towards the center of the frame wherein each petal of the plurality of petals at least partially overlaps an adjacent petal of the plurality of petals such that the plurality of petals interlock.

9. The surgical access assembly of claim **8**, wherein the folded configuration of the instrument seal defines the central hole that is configured to seal against a surgical instrument.

10. The surgical access assembly of claim **8**, wherein each petal of the plurality of petals is flexibly coupled to the corresponding segment of the plurality of segments with a living hinge.

11. The surgical access assembly of claim **8**, wherein the folded configuration of the instrument seal allows the plurality of petals to flex relative to the frame while the frame remains axially stationary relative to the housing.

12. The surgical access assembly of claim **8**, further including a bellows and a retainer, the retainer having a first ring disposed on a first side of the bellows and a second ring disposed on a second side of the bellows, the retainer sandwiching the bellows between the first ring and the second ring to maintain the bellows and the instrument seal in an aligned relationship.

13. The surgical access assembly of claim **12**, further including a guard having a central orifice, the guard disposed between the bellows and one of the first ring or the second ring.

14. The surgical access assembly of claim **13**, wherein the first ring includes pins and the second ring of the retainer includes openings for receiving the pins, the pins of the first ring insertable through bores of the guard, pores of the bellows, and peripheral holes of the instrument seal to maintain the guard, the bellows, and the instrument seal in the aligned relationship.

15. The surgical access assembly of claim **8**, wherein the folded configuration of the instrument seal defines a diameter of the central hole that is configured to seal against a surgical instrument.

16. A surgical access assembly comprising:

a housing;

a tubular member extending from the housing; and

an instrument seal disposed in the housing, the instrument seal having:

a frame having a plurality of segments, each segment of the plurality of segments attached to another segment of the plurality of segments and defining an obtuse angle between adjacent segments of the plurality of segments, and

a plurality of petals corresponding to the plurality of segments, the plurality of petals arranged such that a portion of a first petal of the plurality of petals covers a portion of a first adjacent petal of the plurality of petals and is covered by a portion of a second adjacent petal of the plurality of petals, each petal of the plurality of petals flexibly coupled to the corresponding segment of the plurality of segments by a living hinge;

wherein at least one petal of the plurality of petals defines an acute angle with respect to a top surface of at least one segment of the plurality of segments.

17. The surgical access assembly of claim **16**, wherein the plurality of segments defines a polygonal configuration of the frame.

18. The surgical access assembly of claim **16**, further including a bellows having a first side and a second side, the first side of the bellows facing a first side of the instrument seal.

19. The surgical access assembly of claim **18**, further including a first ring disposed on a second side of the instrument seal, a guard disposed on the second side of the bellows, and a second ring disposed adjacent to the guard, the first ring and the second ring sandwiching the guard, the bellows, and the instrument seal between the first ring and the second ring.

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